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**IMPLEMENTING THE USE OF SIX SIGMA FOR QUALITY AND CONTINUOUS
IMPROVEMENT**

Case company: Ghana Standards Authority (GSA)

Masters' thesis in

Industrial management

Thesis supervisor: Professor Jussi Kantola.

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LIST OF ABBREVIATIONS

TQM	- Total Quality Management
QI	- Quality Improvement
PDCA	- Plan, Do, Check, and Act
DMAIC	- Define, Measure, Analyze, Improve and Control
SPC	- Statistical Process Control
GSB	- Ghana Standards Board
GSA	- Ghana Standards Authority
NRCD	- National Redemption Council Decree
ISO	- International Organization for Standardization
DKD	- Dentscher Kalibrierdeient
CEPS	- Customs and Excise Preventive Service
CTQ	- Critical to Quality
LSS	- Lean Six Sigma
PT BBT	-Perseroan Terbatas Boma BismaIndra
UK	- United Kingdom
SQC	- Statistical Quality control

ABSTRACT

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<p>This thesis investigates the how Six Sigma can be applied to aid to trace the root cause of why the organization under study is not seeing much progress, to find out how to improve the quality of service and also aid in the continuous improvement of the organization. The theoretical framework employed is the Lean Six Sigma (LSS) which deploy the general concept of eliminating waste in any given system or service to promote efficiency through careful usage of the five phases of Six Sigma.</p> <p>The study deploys the use of a qualitative research and data was gathered by submitting questionnaires to the employees of the organization. After a careful analysis of the data by the deployment of the phases of Six Sigma (DMAIC), suggestions and proposals are given for factors that need improvement through management initiative and direction.</p> <p>The overall idea of the thesis was to implement the use of Six Sigma for quality and continuous improvement. The writer hopes that by implementing these proposals of the study, there would be a significant improvement in the quality of services provided and a significant progress would be seen in the organization.</p>	
KEYWORDS: Total quality management, continuous improvement, quality improvement, Six Sigma, Lean Six Sigma.	

1 INTRODUCTION

1.1 Background of the study

Quality is usually used to signify the excellence of a product or service. There have been several attempts by some of the well known names in the area of quality to define what quality actually means. According to Joseph M. Juran, quality could be defined as the fitness for use. Edward Deming stated that quality should be aimed at the needs of the customer, both present and future. On the other hand, Philip Crosby defined quality as the fitness for use. It is without a doubt that all the given definitions of quality are channeled at a single point, which is to meet and satisfy the demands of the customer. (Oakland, 2015) (Madu, 2005)

Another important word that comes to mind whenever we talk about the quality of a product or service is reliability. According to Madu (1999), the quality performance of a firm is often assessed by the reliability of the firm's equipments or machinery. Many organizations today perform effectively due to the fact that they have a highly dependable and reliable system including machinery, process, people and even an organization's system.

Organizations in recent times have experienced a period of massive change in their ways of operation due to the trend of increasing competition both at the domestic and international level. The increase in competition has created a hostile and turbulent environment for many organizations in the world today. Adding up to the pressure of the competition is the pace at which technology is changing and with consumers and regulators demand increasing every day. (Madu, 2005)(Christina, Reliability and quality interface, 1999)

There are several strategic factors that an organization can implement to overcome the turbulence in the environment, have the edge for sustainable competitive advantage over its

competitors and meet customer demand. Among all the strategies, good quality performance has always been the paramount factor for organizational success. To succeed in the competing markets of the twenty-first century means that an organization should have a good quality performance and quality improvement systems in place. (Oakland, 2015)(al, 2014)

The reputation of quality whether good or bad lasts for a long time and can become a stigma both on a national and international level. To this effect, many organizations across the globe have adopted several ranges of quality and management system standards such as lean thinking, six sigma, total quality management (TQM), Plan-Do-Check-Act cycle among others are all positive approaches that organizations have taken to ensure that their products or services are reliable and meets customer demand.

According to John S. Oakland (2014), total quality management (TQM) is a set of systematic activities that is carried out by the entire organization to efficiently and effectively achieve the objectives of the organization so as to provide products and services with a level of quality that satisfies customers, at the right time and price.

Quality improvement (QI) on the other hand could be defined as an approach of analyzing the performance of a system or process and systematic efforts to improve it. There are certain essential ingredients that are important to affect the use of quality improvement as proposed by Kruskal et al and they include institutional leadership and support, culture of quality and safety, process for managing customer relations, quality management team, continuous engagement of all staff in the quality process and the use of appropriate tools. (Oakland, 2015)(Christina, Reliability and quality interface, 1999)(al, 2014)

Kruskal et al again suggested and summarized certain steps that must be considered in a quality improvement process and they include identification and definition of the process or problem, collection and analysis of data to better define and understand the problem, identify all possible contributing factors, select the major root cause, develop solution

strategies, implement, test and evaluate solutions, standardize and deploy the selected solutions and reanalyze the processes and repeat the steps.

There are numerous models used for quality improvement, example of such models include the use of the six-sigma and the Plan-Do-Check-Act cycle (PDCA) developed by Walter A. Shewhart which was later modified to Plan-Do-Study-Act (PDSA) by W. Edwards Deming. (Christina, Reliability and quality interface, 1999)(al, 2014)

After assessing the importance of quality and continuous improvement, the study was aimed at implementing the practical use of Six Sigma for quality and continuous improvement which follows the projected methodologies inspired by Deming and Shewhart. It made it easy to answer the following question; what are the areas that needs to be improved in order to overcome the obstacles the hinder the progress of the organization and what are the barriers that is preventing the organization from implementing its strategic objectives. Six Sigma was used to help find out the key areas that need to be improved. The steps in six sigma are define, measure, analyze, improve and control or (DMAIC).

This was a case study and the use of a qualitative research approach was implemented using Ghana standards authority as the case company. In the introduction, it was stated the Ghana standards authority consist of seven divisions, but in this study, only one division that is metrology was considered. The study involved the practical use of Six Sigma to conduct a quality improvement assessment by trying to assess certain variables such people, process, equipment, materials, environment and management.

The histogram is one of the seven basic total quality management tools used in summarizing, displaying and analyzing process data. It is an analyzing tool that can be used to analyze variations of data within intervals of variables. The histogram was used to provide a graphical representation of the results from the study so as we enable us see which areas has the most occurring frequency which then represented the area of most concern which needs to be addressed.

Quality improvement may also be implemented using the seven basic quality improvement tools which includes the cause and effect diagram (fishbone or the Ishikawa), check sheet, pareto chart, scatter diagram, flow chart, statistical process control (SPC) and the histogram. (al, 2014) (Madu, 2005)

The study was conducted at Ghana standards authority (GSA) located in West Africa. The Ghana standards authority (GSA) was established by the Standards Act, 1973 (NRCD 173). Ghana standards authority is the national statutory body responsible for the management of the nation's quality infrastructure embracing metrology, standards, testing, inspection and certification. The name Ghana standards board (GSB) was changed to its current name Ghana standards authority (GSA) in 2011.

The authority was mandated to carry out certain task or duties including providing quality assurance through inspection, testing and metrology, assisting operators in both the manufacturing and service sectors to improve their competitiveness by establishing effective quality management systems along ISO 9001: 2008 and 22000: 2005, promoting standardization in industry and commerce promoting standards in public and industrial welfare, health and safety.

Like any other establishment, the authority has certain core activities and they include metrology calibration, verification and inspection services for weights, measures, weighing and measuring instruments, standards development and promotion of standards. In the area of inspection, it covers inspection activities of imports and exports as well as of products offered for sale in the country.

The authority also ensures the testing, technical examination and analysis of goods serving as an independent third party undertaking product or system certification which aims to provide confidence that a product complies with national or international standards and specifications.

The authority consists of the following divisions; metrology, standards, testing, certification, inspectorate, administration and organizational development, finance and

corporate planning and monitoring and evaluation. For the purpose of this study, only the metrology division would be considered.

Metrology could be defined as the science of precise or accurate measurement. The scope of work carried out under this division includes mass measurements which deals with the measurement of weight, balances and weigh bridges, flow measurements which handles the measurements of storage tanks and flow meters, dimensional and linear measurements, pressure and force measurements, crane testing, temperature measurements, electrical parameters measurement and time and frequency measurements.

The Metrology Division of the Ghana Standards Authority has its entire National primary Standards traceable to the Dentscher Kalibrierdienst (DKD) Laboratories in Germany and it is the custodian of the Weights and Measures Decree, NCRD 326, 1975 in Ghana. It undertakes activities in Legal, Scientific and Industrial Metrology towards the development of a national measurement scheme to support Science, Industry and Commerce. Figure 1 below gives an overview of the organizational structure of Ghana standards authority.

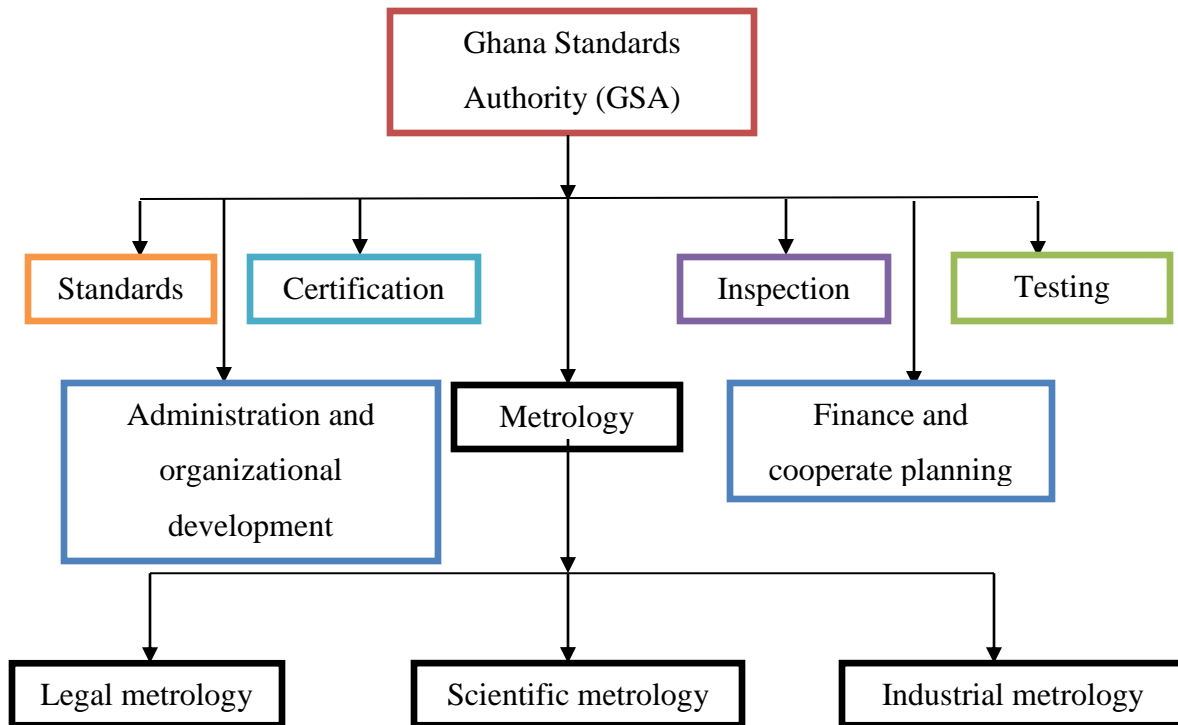


Figure 1: The organizational structure of GSA and the division under study

Legal Metrology involves all measurements which are subjected to legal or regulatory control. The Legal Metrology Department is responsible for verifying weights, measures, weighing and measuring instruments of corporate organizations such as Ghana Police force and a few individual set ups with the aim ensuring fair trading practices through the verification of weights and measures.

The legal department also organizes trading seminars for stakeholders to build their capacity on measurements and related subjects. Table below indicates category of establishments and the instruments being verified for them

Category of Establishment	Verified Instruments
Oil Marketing Companies (Service and Fuel Stations)	Fuel pumps, T-Bars, Thermometers, Visugauges
Cocoa Industry	Weighing Scales and Test Weights
Courier Companies, Airports, Harbors and Post Offices	Weighing Scales
Supermarkets	Weighing Scales
Customs and Excise Preventive Service (CEPS)	Weighing Scales

Table 1: Areas of measurement covered by the legal department

The Scientific Metrology Department of the Division on the other hand is responsible for the calibration of laboratory, medical and other equipment. The department has three of its laboratories (Temperature, Mass and Pressure) been accredited to ISO/IEC 17025:2005 by DKD of Germany.

Area of Measurement	Examples of equipment range
Mass Measurements	Laboratories analytical balances, platform, weighing scales, top loading scales, test weights, and other weighing devices
Flow / Volume Measurements	Glassware, Fuel dispensing pumps, gas dispensers and oil decanters
Dimensional / Linear Measurements	Micrometers, vernier calipers, measuring tapes of all kinds, sieves etc.
Electrical Measurements	Voltmeters, Ammeters, multi-meters, energy/power meters, ohmmeters, phase value equipment.
Pressure and Force Measurements	Torques, pressure gauges, compression and tensile testing machines, sphygmomanometers, tyre pressure gauges.
Temperature Measurements	Industrial thermometers, Liquid-in-glass thermometers, water bath and Climatic Chambers
Force Measures	Torque Wrenches
Time, frequency and Speed Measurements	Stop watches, frequency measuring devices, hand held radars
Medical Instruments/Devices	Clinical thermometers, Sphygmomanometers, Weighing scales, Climatic chambers
Other Laboratory Measuring Instruments	Hydrometers, hygrometers, pH meters, spectrophotometers, (GC, IR, UV), measuring cylinders, pipettes, burettes, volumetric flasks.

Table 2: Areas of measurement covered by the scientific department

Industrial Metrology Department is responsible for the calibration of industrial weights, measures, weighing and measuring throughout the country (Ghana). More clients in the manufacturing and service sectors are gradually presenting their equipment for calibration through the awareness creation and effort made by the authority on the benefit of calibration. In addition to this, the Department also organizes training seminars on measurements for industries with regards to the use and calibration of process control equipment.

Area of Measurement	Examples of Equipment Range
Mass Measurements	Weighbridges, top loading scales (cranes), test weights, industrial hoppers and other weighing devices.
Flow/Volume Measurements	Flow meters, Storage tanks, Prover tanks, Visugauge, bulk water meters, bulk road vehicles, fuel dispensing pumps, gas dispensers and oil decanters.
Force Measures	Compression Testing Machines, Torque Wrenches

Table 3: Areas of measurement covered by the Industrial department

1.2 Objective of the study

The mission of Ghana standards authority is to promote standardization for the improvement of the quality of goods, services and sound management practices in industries and public institutions in Ghana. Ghana standards authority over the year has done its best to ensure the fulfillment of its mission. In order for the authority to be able to achieve its future vision which is to become a model of excellence in standardization in Africa, certain key areas of its operation need to be improved in order to overcome the unknown turbulence in the future.

A quality and continuous improvement check was conducted using the six sigma to define, measure, analyze, improve and control key areas within the set division to measure the

performance of certain parameters such as process, people, equipments, materials and the working environment, . The aim of the study is to see which area needs to be watched and improve upon in order to improve upon the performance of the division.

1.3 Background assumption

It is without a doubt that every organization is aware of the importance of quality and continuous improvement. Many organization around the world more especially in Africa do not make use of the quality and continuous improvement tools to effect changes in their systems or operations.

However, organizations in Europe, Asia and the United States of America have constantly implemented the use of quality and continuous improvement tools to assess and find areas to improve within their operations and have seen an increase in the outcome of their activities.

Ghana standard authority (GSA) is the sole provider of standards and quality assurance through inspection, testing and metrology to the public and therefore the issue of quality assessment to improve the quality of its system is an important and relevant topic for the organization. It is based on the assumption of the importance of quality improvement that the study seeks to find out if there are areas within the said division under study that might need some improvement. (Oakland, 2015) (Madu, 2005)

1.4 Limitation to the study

Due to time constraint, the study was conducted only in one division out of the seven divisions of the organization, it is therefore difficult to get the bigger picture of how the results could reflect in the other divisions. Furthermore, one cannot to entirely sure if the respondents' answer the questions truthfully in order to cover up for the good name of the department they work in.

The sample size for the study would have been bigger if other divisions were added to the study. For the fact that only one division was considered for this study and the sample size not large enough, one might not be able to get the bigger picture of the entire problem for the organization, however it works and gives the picture for the division under study.

1.5 Structure of the paper

The study followed a scientific model, it begun with the introduction of the study, research methods and materials, results analysis, discussion of the results and finally conclusion and recommendation.

In the introduction, the background of the study, objectives, background assumption, and the research question were discussed. This was aimed at giving the reader an overview of the entire research right from the general view to a more specific target of the study. The theoretical and conceptual framework in chapter two provides all the relevant theories and the framework under which the study was conduct so as to achieve the object of the study.

The empirical part of the study gave a detailed investigation into the activities of the said metrology division using the appropriate tool and the right methodology deployed by the use of the DMAIC steps of Six Sigma to try to locate areas that might need improvement.

The findings from questioners that was administered to the workers was then be analyzed using the correct data analyzing tool.

The results that were attained from the analysis were carefully interpreted and discussed in detail to give an understanding or translation of the results. Recommendations and conclusions of the results together with managerial implication of the study were given based on the results and data that were analyzed. Figure 2 below gives on overview of the structure of the thesis.

<p>CHAPTER 1 INTRODUCTION</p> <ul style="list-style-type: none"> ✓ Background of the study ✓ Objective of the study ✓ Back ground assumption ✓ Limitation to the study ✓ Structure of the paper
<p>CHAPTER 2 THEORETICAL AND CONCEPTUAL FRAMEWORK</p> <ul style="list-style-type: none"> ✓ Quality ✓ Total quality management ✓ Total quality tools ✓ About Six Sigma ✓ Processes or phases in Six Sigma <ul style="list-style-type: none"> • Define phase • Measure phase • Analyze phase • Improve phase • Control phase ✓ Theoretical framework ✓ Applications of Six Sigma ✓ Research model
<p>CHAPTER 3 RESEARCH METHODOLOGY</p> <ul style="list-style-type: none"> ✓ Definition of the project ✓ Measuring of the key variables <ul style="list-style-type: none"> ✓ Analyzing the result ✓ Improvement based on the results ✓ controlling the process based on the results
<p>CHAPTER 4 RESULTS ANALYSIS</p>
<p>CHAPTER 5 DISCUSSION OF RESULTS</p>
<p>CHAPTER 6 RECOMMENDATION</p>
<p>CHAPTER 7 CONCLUSION</p>
<p>REFERENCES</p>
<p>APPENDICES</p>

Figure 2: The structure of the thesis

2 THEORETICAL AND CONCEPTUAL FRAMEWORK

This chapter is meant to demonstrate available knowledge about the Six Sigma, the methods and tools used during the Six Sigma phases and try to give a holistic view of some of the areas where the Six Sigma has been successfully implemented. This was done in order to gain a deep understanding on the effectiveness and efficiency of the Six Sigma in today's competitive market where customer (both internal and external) satisfaction is the focal point for the survival of any organization. This chapter will also provide a theoretical framework relating to new findings to previous findings during the discussion section. Without a feasible establishment of previous research, it could impossible to establish how the new research advances the previous research.

2.1 Quality

The International Organization for Standardization published its first quality management standards in 1987. However, the history and origin of quality can be traced back to the ancient Egyptians where scientist argued that construction of the pyramid itself, the tools and the measured used was professional carried out such that it ensured the quality of work carried out. (Alexandre Pignanelli, 2008) (Yang liu, 2013)

Over the course of time, quality management has evolved from a low level to a standardized quality system where all the process with a organization is well studied and the outcomes are measured, analyzed and documented. Organizations around the world have been force to adopt to current changes dues to the technological innovations in quality management systems. (Yang liu, 2013) (Oakland, 2015)

Quality management in the twentieth century was seen by some of the pioneers of the quality movement (Joseph M. Juran , Armand V. Feigenbaum , Phillip B. Crosby and, specially, William E. Deming) as the internal factor that gives competitive advantage to one

organization over the other that could lead a higher level of performance including financial performance. (Brocka, 1992) (Oakland, 2015)

The term quality has been defined on several dimensions, for example, Walter Shewhart gave his own definition of quality as the goodness of product. Dr. Joseph Juran defines quality as “fitness for use” and Philip Crosby explains quality as “conformance to requirements”. However, these definitions are only limited to products and did not consider services. Over the course of time, the definition of quality was widened to suit both products and services. (Oakland, 2015) (Yang liu, 2013)

Nevertheless, a study was conducted in the United States where several managers were asked for their definition of quality. Their definitions includes *perfection, consistency, eliminating waste, speed of delivery, Compliance with policies and procedures, providing a good, usable product, doing it right the first time, delighting or pleasing customers and total customer service and satisfaction*. (Oakland, 2015) (Yang liu, 2013)

2.2 Total quality management

After world war one, several industries recorded a very poor level of production and in order to resolve this issue, the general idea of total quality management (TQM) was adopted. Auditors and inspectors were placed on production lines to fish out faults and defect which lead to poor quality in production. Over the course of time the statistical quality control (SQC) was introduce which was a cheaper and more effective technique to tackle the issue of poor quality in production.

Quality management over the years has been considered to be the backbone for sustainability in many areas of operation. There have been several definitions to the term total quality management (TQM), one definition that cut across or unanimously joins together these several definitions is that TQM is philosophy that generally includes practice, tools and principles that is directed towards continuous improvement, customer focus and above all fact decision making. (Vanaja Siva, 2016) (Oakland, 2015).

Though TQM is very important to the survival of an organization, certain principles must be adhered to in order to make the practice of TQM effective and they include

- . Executive management commitment to practice TQM
- Computer aided statistical process and quality monitoring software and technology to improve deviation and variation in the products
- Training in computerized statistics tests and application for sample checking, usage of data checking errors in the manufacturing process
- Decision making on the measurement of results
- Proper computerized procedural evaluation of employees' performance regarding output
- Organizational support for employees to work in teams
- Employee empowerment and involvement in tasks
- Responsibility and accountability on job
- Continues improvement
- Customers focus products and services to satisfy and retain them

The general concept of the TQM over the course of the years has gone through several changes and improvements, these changes resulted in the creation of the Six Sigma. The Six Sigma works based on five principal phases known as DMAIC (Define, Measure, Analyze, Improve and Control). (Asiya Gul, 2012) (Vanaja Siva, 2016) (Oakland, 2015)

2.3 Total quality management tools

Total Quality Management (TQM) tools, are management tools used for identifying, analyzing, quality planning, quality control, quality assurance and troubleshooting problems by making use of both qualitative and quantitative data. TQM tools identify procedures, ideas, statistics, cause and effect concerns and other issues relevant to an organization and production processes such that when examined, it enhances the effectiveness, efficiency, standardization and the overall quality of the organizations'

procedures, work environment and products in accordance with the ISO 9000 standards. (Oakland, 2015) (Brocka, 1992)

TQM tools can be compared to the carpenter's tools or the engineers tools, always use the right tool for the right job. The tools includes Statistical Process Control (SPC), Pareto chart, Process chart, Check sheet, Histogram, Cause and effect diagram (Fish bone diagram) and the Scatter diagram.

2.3.1 Statistical process control (SPC)

This uses statistics models to give a very good picture about a process, which is complicated. It relies heavily on accumulated data over a period of time. For better understanding of the presentation of the SPC, it is very important to arrange all the data points in order and plot them on a graph known as the Statistical Process Control (SPC) chart. (Brocka, 1992) (Oakland, 2015)

The SPC charts are used to detect if the process has a tendency of going out of control and to monitor times and customer satisfaction. It is mostly used to *monitor process in a production* or service to prevent poor quality.

The SPC like other TQM tools can be applied in many areas of operation for example;

- Hospitals for measuring timelines and quickness of care
- Grocery stores for measuring the time for customer waiting and checking out
- Airlines for checking flight delays, lost luggage
- Insurance companies for checking timelines of claiming process

The SPC establishes control limits for a process, usually the organizations tries to set upper and lower bands and they expect that at the end of a set period, the process to be measured should not fall above or below the set limits.

The process output is measured with respect to time and if at any given time a process goes above or below the set limit, the organization can then put measures in place to find out the exact cause and try to eliminate that cause if possible. (Brocka, 1992) (Oakland, 2015)

2.3.2 Check sheet

A check sheet is a tool for data gathering, and a logical point to start in most process control or problem solving effort. (Oakland, 2015). It is particularly useful for recording direct observations and helping to gather facts rather than opinions about the process. The use of simple check sheets or tally chart aids the collection of data of the right type, in a right form at the right time. The objectives of the data collection will determine the design of the record sheet used. (Brocka, 1992)

A check sheet is typically a blank form that is designed for the quick, easy and efficient of recording desired information, which can be either quantitative or qualitative. When the information is quantitative, the check sheet is called a tally sheet. These sheets are used to record the occurrence of activities. In a table or diagram form they are extremely useful as a data collection and record to supplement attributes quality control chart. (Ang Boon Sin, 2015)

2.3.3 Cause and effect diagram (Fish bone diagram)

As problems occur in everyday life and particularly in organizations with a goal on target, managers (and in fact all stakeholders) usually find a way of identifying what the root cause of any problem is. (Brocka, 1992) (Christina, Reliability and quality interface, 1999)

Amongst the many tools employable is the popular Cause and Effect diagram, which is also called the Fishbone diagram or sometimes the Ishikawa Diagram (After the Inventor- Dr. Kaoru Ishikawa). This is most effective in order not to just solve the emerging effects of the problem but rather getting to the main cause by systematically locating and identifying

the root cause and dealing effectively with the issue, this diagram based method which combines thinking (analyzing) the entire processes with a mind map makes it possible to consider all probable causes rather than the seemingly obvious one. It is thus implemented to discover the root cause of a problem, determine bottleneck in a process cycle and identify where, why and even when a process is not working. Thus the cause and effect diagrams present a thorough analysis of the situation. It is most useful when investigating complicated causes of problems in many instances from industry to crime detection. (Pearl, 2000)

2.3.4 Histogram

A Histogram is one of the seven basic total quality management tools used in summarizing, displaying and analyzing process data. It can also be seen as a graphical representation of a table showing proportion of cases that fall into each of specified categories. It was introduced by Karl Pearson (1857-1936) as a way of showing the probability distribution of continuous variables. (Hagan, 1994)

Histograms consist of tabular frequencies, shown as adjacent rectangles, erected over discrete intervals with an area equal to the frequency of the observations in the interval.

It is an analyzing tool that can be used to analyze variations of data within intervals of variables. It is better used when there are numerical data, with the intent of showing effectiveness and or differences in survey, statistical or questionnaire results. (Hagan, 1994) (Oakland, 2015)

2.3.5 Process chart

Process chart can be defined “as graphical representation of the sequence of steps or tasks (workflow) constituting a process, from raw materials through to the finished product. It serves as a tool for examining the process in detail to identify areas of possible

improvements. It is a tool which is applicable in engineering, business and other areas of life. Process charts can be used to define and analyze processes, communicate steps to other people involved in a process, standardize a process, improve a process and identify bottlenecks or troubleshoot a problem. (Damelio, 1996) (Galloway, 1994) (Boutros, 2016)

2.3.6 Scatter diagram

Scatter diagram is a total quality management tool used to improve the overall quality and standardization of product and organizational effectiveness. It can also be referred to as scatter plot, scatter diagram or X-Y graph (Total quality management). It displays the possible relationship between two different variables using data points on graph as shown below. It is used, quality wise, to illustrate the corresponding effect of a changing variable on another variable in a system. (Nygrén, 1996) (Pollari, 1996)

Some examples of scenarios that scatter diagram could be used include cutting speed and tool life, breakdowns and equipment age, training and errors, production speeds and defective parts. The relationship between two different variables is called Correlation. Correlation can have a positive, negative or null relationship. When plotted, the degree of relationship between the variables is determined by how close the variables are to forming a line. (Nygrén, 1996) (Oakland, 2015)

The direction of the graphical data points depicts the type of correlation. If the direction of both variables increases accordingly, then the relationship is a positive relationship. If the one variable increases in y-direction and the other decrease in x-direction, it is negative. Moreover if there is no direction, it is null correlation. (Oakland, 2015) (Pollari, 1996)

2.3.7 Pareto chart

Pareto Chart, named after Italian economist Vilfredo Pareto (1848-1932), is a quality control tool, which can be used to determine the *percentage of problems* can be attributed

to each incident. This chart is constructed by histogram bars and line graph. Chart plotting with frequency causes on X-axis and cumulative percentage on Y-axis. Each category of defect type is showed by column, and the percentage of each categorized defect. (Oakland, 2015) (Brocka, 1992)

Pareto chart are often used in both the measure and analyze steps of DMAIC (Define, Measure, Analyze, Improve and Control), the charts are extensively used in Non-manufacturing applications of quality improvement methods. Combining with check Sheet, the investigated defects construct the frequently occurring types of defects. Then, to separate 100% into each incident, and draw a cumulative line is close unlimitedly to 100%. It is helps the analyzer to determine which defects are most frequent happens in the management. (Oakland, 2015)

Pareto analysis which combines Pareto Principle (also known as the 80/20 rule) with Pareto Chart, shows the probable result will be that the bulk (typically 80 per cent) of the errors, waste, or 'effects', derive from a few of the causes. (Oakland, 2015) (Brocka, 1992)

2.5 About Six Sigma

The concept of Six Sigma was developed in the 1980s by Motorola to increase productivity and help eliminate operational waste. The Six Sigma today is one of the most important quality and continuous improvement tool that have been abducted by several industries across the globe. Aside it's primarily objective of improving upon organizational efficiency and customer satisfaction, Six Sigma also helps in cutting down operational cost and increases profit. (Ang Boon Sin, 2015)

The methodology of Six Sigma have am important place for the development and reducing of any action which does not have any important contribution within the inner process of any given organization. The methodologies developed in Six Sigma uses a systematic approach to provide quality improvement and also provide a very flexible process that can be applied in almost every given organization right from education to manufacturing, from

health care to transportation, from small scale businesses to multimillion dollars industries. (S.E. Mason, 2014) (Hikmet Erbuyik, 2015)

Over the past years, the economic crisis has pushed several organizations to find a profitable solution that would allow organizations to gain a competitive advantage over its competitors. The Lean and Six Sigma is one of the most used management methodologies that have given organizations the edge to improve upon their products, improve their process, cut down cost, provide customer satisfaction and increase profit. (Alexandra Tenera, 2014) (Hikmet Erbuyik, 2015)

Several attempts have been made to try and define what Six Sigma is. Ang Boon Sin et al (2015) in their article stated that Six Sigma is a business strategy that helps organizations to improve organizational efficiencies and customer satisfaction. (Ang Boon Sin, 2015). On the other hand, Hikmet Erbuyik et al (2015) defined Six Sigma as the process of quality management the leads us to excellent quality level via continual improvement process. It is evident that the Six Sigma is nothing but a customer focused strategy that helps eliminate any form of mistake and improves efficiency (Hikmet Erbuyik, 2015).

Some added that the Six Sigma methodologies rely on various statistical techniques to come out with accurate findings. They defined Six Sigma has a quality improvement approach that improve organizational performance based on the use of various statistic analytic technique. (Dyah Diwasasri Ratnaningtyas, 2013). The sigma (σ) is the symbol for standard deviation and this is just the measurement for statistical dispersion and spreading, to this effect it is argued that the bases of the Six Sigma is related to statistics. (Hikmet Erbuyik, 2015).

Six Sigma aims to eliminate all the variations within any given process and to improve the process to provide all the necessary quality demands of the customer. This can be achieved by implementing certain tools and techniques. These tools and techniques include cause and effect diagram, histogram, pareto chart, control chart, check sheet, scatter diagram and flow chart. (Frank Voehl, 2014).

2.6 Process or phases in Six Sigma

Six Sigma process improvement is a methodological steps which follows a five step-by-step phase of Define, Measure, Analyze, Improve and Control (DMAIC). These processes were designed or deployed in order to have a better understanding of an arising issue and find ways of tackling them. (Ang Boon Sin, 2015) (Christyanti, 2012).

DMAIC is a very well structured problem solving technique that most organizations across the globe use in their everyday business. It logically leads a team through a simple systematic phases of defining a problem and deducing a solution that a linked to underlying the causes of the problem, draw down the best practices to ensure that the solution stays in place. It must be noted that the DMAIC should be seen as a closed-loop process in the sense that it is a continuous improvement technique which never ends but the cycle repeat itself in order to increase productivity. The process tries to eliminate unproductive steps by concentrating on new measures and apply steps for continuous improvement. (Christyanti, 2012) (Michael L. Geoarge, 2005).

The structure of DMAIC does not only help in problem solving to fulfill customer demands but it also encourages and create an atmosphere for creative thinking such as keeping the basic services, product and process. The basic framework of DMAIC works in a wide area of problem solving more especially in this twenty first century where fulfilling of customer demands is key to the survival of any given organization. (Michael L. Geoarge, 2005). The original task or purpose of the DMAIC was for variation reduction within the manufacturing process. Due to the success and effectiveness of the implementation of these processes, it was later used widely by organizations to improve upon the quality of performance, efficiency of operations, cost reduction and customer satisfaction. (Jeroen de Mast, 2012).



Figure 3: DMAIC Step

2.6.1 Define phase

This involves defining the scope and problem that the project is aimed at resolving. The definition of a problem is mainly done by reviewing the feedback from customers. Several organizations have setup a plan to help them define the scope or problem the need to be looked into. These steps includes; validation of problem statements and goals, reviewing of project charter, validation of financial benefits, validation of high level stream map and scope, creating of communication plan, selecting and launching of the team to handle the project and developing a project schedule. (Michael L. Geoarge, 2005) (Dyah Diwasasri Ratnaningtyas, 2013).

According to Jeroen de Mast and Joran Lokkerbol (2012), the success of defining a project and effectively creating a benefit analysis is relevant to achieving the entire aim of the project and depends on identifying and mapping of relevant processes such as identifying

key stakeholders, determining and prioritizing of customer needs and requirements and finally making a business case for the project. (Jeroen de Mast, 2012)

2.6.2 Measure Phase

This measures the performance of quality of the current process; it may include data collection and evaluation of data to identify the performance of a given process. (Dyah Diwasasri Ratnaningtyas, 2013). Several organizations have setup a plan to help them define the scope or problem the need to be looked into. These steps includes; value stream mapping for dipper understanding , identifying for key input process and output metrics, developing of data collection plan, developing operational definitions, validation of measurement systems, collection of baseline date and determine process capability. (Michael L. Geoarge, 2005) (Dyah Diwasasri Ratnaningtyas, 2013).

The success of measuring a problem into a form that is acceptable and gives an accurate measure of the situation can be done by selecting one or more of the critical to quality (CTQs) which is aimed at innovative solutions to improve quality, determine operational definitions for CTQs and its requirements, validation of measurement systems of the CTQs, access the process capabilities and define the objectives of the measurements. (Jeroen de Mast, 2012).

2.6.3 Analyze Phase

The main objective of the analyze phase is to help is the analysis of the performance of any given system to separate all the necessary problems. (Dyah Diwasasri Ratnaningtyas, 2013). This is seen as a crucial phase of DMAIC in the sense that any wrong analysis carried out would lead to identifying the wrong problem rather than actual problem. Identification of influencing factors and the main causes can be carried out by first trying to identify the potential influencing factors and selection of the few vital factors. This is can

be successfully done is the scope of the entire DMAIC phases are carefully and well planned. (Jeroen de Mast, 2012)

Furthermore, the analyze phase of DMAIC can be achieved by determining the critical inputs, identifying all the potential root cause of a problem, reducing the list of all the potential root cause, confirming the potential effect of the root cause on the output, estimate the potential damage of effect of these root cause on the output and prioritizing the root cause in accordance with the effect they have on the output. When this is successfully done, it can help in the analysis phase in order to effectively detect the cause of a problem. (Michael L. Geoarge, 2005) (Jeroen de Mast, 2012)

2.6.4 Improve Phase

This phase basically seeks to improve upon the performance based on the analysis made by given solutions to the potential problem that has been analyzed. (Dyah Diwasasri Ratnaningtyas, 2013). Improvement can be carried out by designing and implementation of adjustments to the process to improve upon the performance of the CTQ. This is done by quantifying the relation between the possible cause of a problem and its effect on CTQ, implementing needed actions to help modify all the process by putting measures in place to ensure that CTQ are optimized and finally by conducting a pilot test to see how effect the measure put in place would help resolve the root cause problems. (Jeroen de Mast, 2012)

Some organizations have their own process they follow to help improve upon their process, they start by developing potential solutions to the problems that has been analyzed, then they select and prioritize the best solution, develop a value stream map after which they try to develop and implement the a pilot solution, confirm the attainment of their project goals and finally develop a full scale implementation plan based on the result of their pilot solution. (Michael L. Geoarge, 2005)

2.6.5 Control Phase

The control phase of DMAIC is to help control the process or product which has been improved to ensure that the target for the entire process or project is attained. It is just not enough to go through the entire phase of Six Sigma and not measures in place to control the output of the process. (Dyah Diwasasri Ratnaningtyas, 2013). The verification of the results of the project and other activities such as adjustment of the process management and control system needs to be carried out to ensure that all the improvement made are sustained over a long period and continuously improved upon. This is can be done by determining new process capabilities and always seeking to implement control plans. (Jeroen de Mast, 2012) (Oakland, 2015)

Ensuring that the process is kept under control can be a huge task, to this effect; there are certain procedures to ensure that this is achieved. Organizations can implement an ongoing process measurement to ensure that the solutions implemented to the cause of problems are effective. They can also identify opportunities to apply project lessons to help keep the system or process under control. (Michael L. Geoarge, 2005).

2.7 Theoretical framework

The theoretical framework of the project is based on the concept of the use of Lean for eliminating waste and enhancing the efficiency of a system, product or service. The Lean and Six Sigma are both improvement methodologies that are used in many organizations by simply implementing certain systematic procedures to ensure that quality improvement in achieved. (S.E. Mason, 2014).

Though both the Lean and Six Sigma deploy the use of the same concept, most expects view the Lean has the power house that has the Six Sigma has one of its methodologies. The Plan-Do-Check-Act as proposed by Walter A. Shewhart could also be seen as one of

the continuous improvement tools or methodologies that some organizations deploy in order to enhance their performance. (Oakland, 2015) (S.E. Mason, 2014).

Though the Lean is channeled at reducing waste by carefully analyzing the entire process and Six Sigma is channeled at reducing waste or detecting defects by address the root cause of a problem, many literature works use the name Lean Six Sigma (LSS) in the sense that it is so difficult to distinguish between the two concepts. Both the Lean and the Six Sigma perform the same duty of trying to remove defects and promote efficiency within a system, product or service. Combining both concepts has been more effective in enhancing more efficiency and time of implementation of necessary steps to achieve the objectives of creating the Lean Six Sigma (LSS) concepts. (Oakland, 2015)

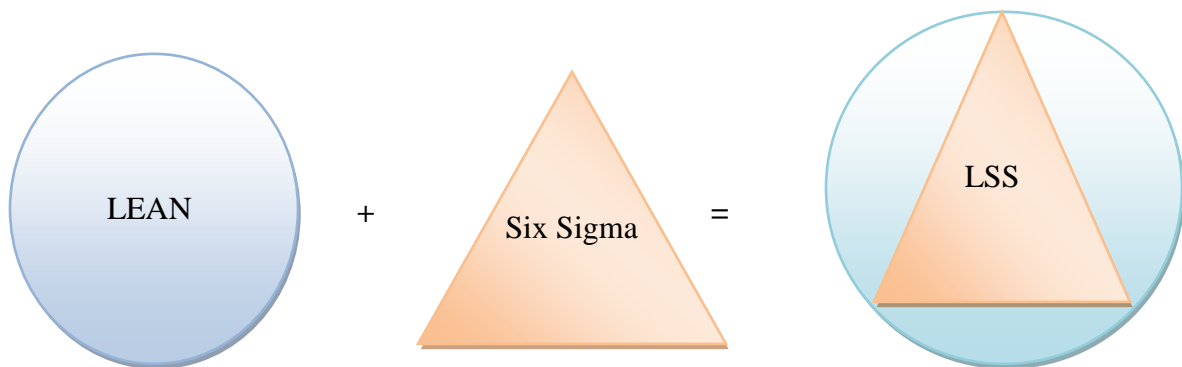


Figure 4: Framework for the thesis

2.8 Application of Six Sigma

Over the years, Six Sigma has been applied throughout every business set up. This is due to the flexibility of the methodologies deployed in the use of the Six Sigma. For example, In Indonesia, many of the housing constructors are using asbestos roofing which is partly supplied by Perseroan Terbatas Boma Bisma Indra (PT BBI) among many other suppliers.

PT BBI has the quality of asbestos roofing among its top priorities and hence it uses the Six Sigma for improving the quality of asbestos roofing. After a successful implementation of the methodologies in Six Sigma the company was able to come out with reasonable conclusion to help improve the quality of asbestos roofing. (Christyanti, 2012).

Furthermore, the use of the Six Sigma has also been deployed in engineering firms over the years to improve the quality of performance. An example was the use of Six Sigma to enhance the effectiveness of shell and tube heat exchanger. The aim of the study was to use Six Sigma to identify and reduce multiple operational energy losses to improve the overall efficiency of the furnace.

Since the 1990s, the use of Lean and Six Sigma has been used and applied in the health care settings. A typical example is the use of Lean and Six Sigma methodologies in surgery in the UK with the aims of optimizing the outpatient efficiency and experience, improving operating theatre experience, decrease operative complications, reduce ward-based harms, reduce mortality and limit unnecessary cost and length of stay. (S.E. Mason, 2014).

In addition to this, Six Sigma has also been used in the medical field to improve the quality of operation theatre. A study was conducted in Bangalore India with the aim of improving the process in an operation theatre of a corporate multi special hospital. The results from the study gave management of the hospital strategic dimension to reform the systems within the hospital in order to obtain a zero error hospital. (Rohini. R, 2011).

2.9 Research model

The knowledge view of the organization provided the platform that enabled the research to be conducted with the use of the DMAIC steps of Six Sigma in order to improve upon the performance of the organization. Organizational knowledge also involves the ability of the firm or organization to create and ensure that the knowledge is spread throughout the entire organization and put measures in place to ensure that the knowledge created is reflected in the quality of product, service and systems.

Organizational knowledge creation has been the key to the success of most Japanese companies over the past decades. Knowledge creation does not only provide the competitive edge but also create a platform that allows companies and organizations to be more innovative. (Takeuchi, 1995).

There are several theories especially in the area or field of knowledge management, however, very few provided the grounds or encourage the use of knowledge creation to enhance research work. (Takeuchi, 1995) (Ang Boon Sin, 2015). Figure 5 below shows the model behind the thesis.

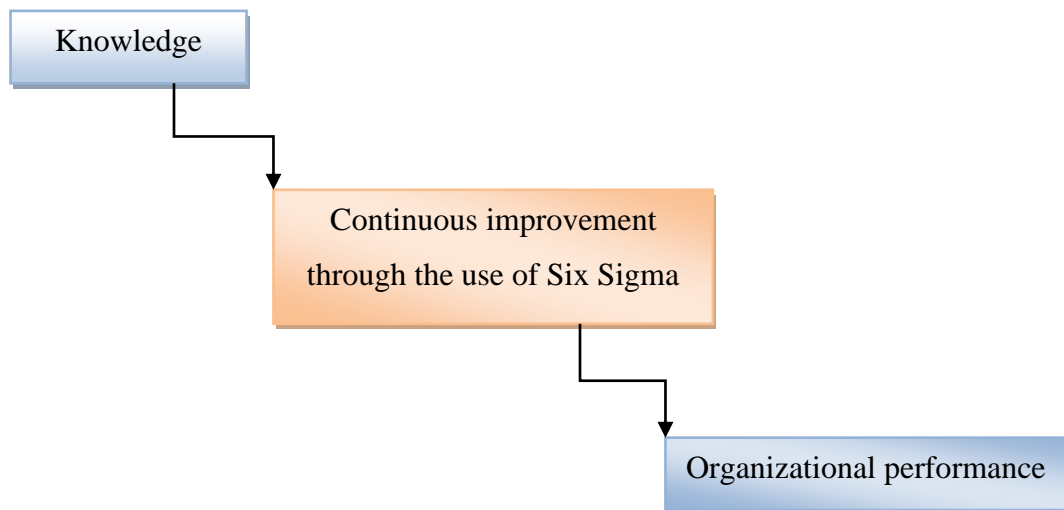


Figure 5: Research model

The term knowledge could be defined as a mix of several variables such as experience, values, contextual information. There are several diversities of knowledge, some see knowledge within a person's as a part of parcel of human complexity and unpredictability. The term knowledge simply consists of partly data and partly information. Nonaka (1994)

gave a critical view or observations about knowledge stating that could be view in three ways. Firstly, knowledge is about beliefs, secondly about action and thirdly about meaning. (Nonaka 1994)

The entire project was based on the knowledge that was generated not only from the literature review on Six Sigma but also on knowledge that was obtained by carefully studying the organization and trying to find out key areas that need to be addressed in order to improve upon the quality of service provided.

In addition to this, the organization over the years has gathered more knowledge on what it expects to improve in order to improve its operations and provide customer satisfaction. This knowledge was considered during the planning phase of the study and the research was carefully planned around the existing knowledge.

The DMAIC steps of Six Sigma were seen to be the best among many other methods due to its simplicity and effectiveness that would aid in carrying out the project so as to achieve the objective of the research. In order for the organization to have a system the will create t he plat form for continues improvement, it was important to use a continuous improvement tool and Six Sigma is among such tools and hence used for the study.

Organizational performance can be enhanced is the results from the research are carefully analyzed and recommendations based on the results are implemented.

3 RESEARCH METHODOLOGY

This was a case study and the use of a qualitative research approach was implemented using Ghana standards authority as the case company. In the introduction, it was stated the Ghana standards authority consist of seven divisions, but in this study, only one division that is metrology was considered. The study involved the practical use of Six Sigma to conduct a quality improvement assessment by trying to assess certain variables such people, process, equipment, materials, environment and management. The data for the study were collected through a survey by distributing questionnaires to the employees.

The DMAIC steps were particularly useful in all the stages or the research. The figure below shows how the entire steps or phase was handled.

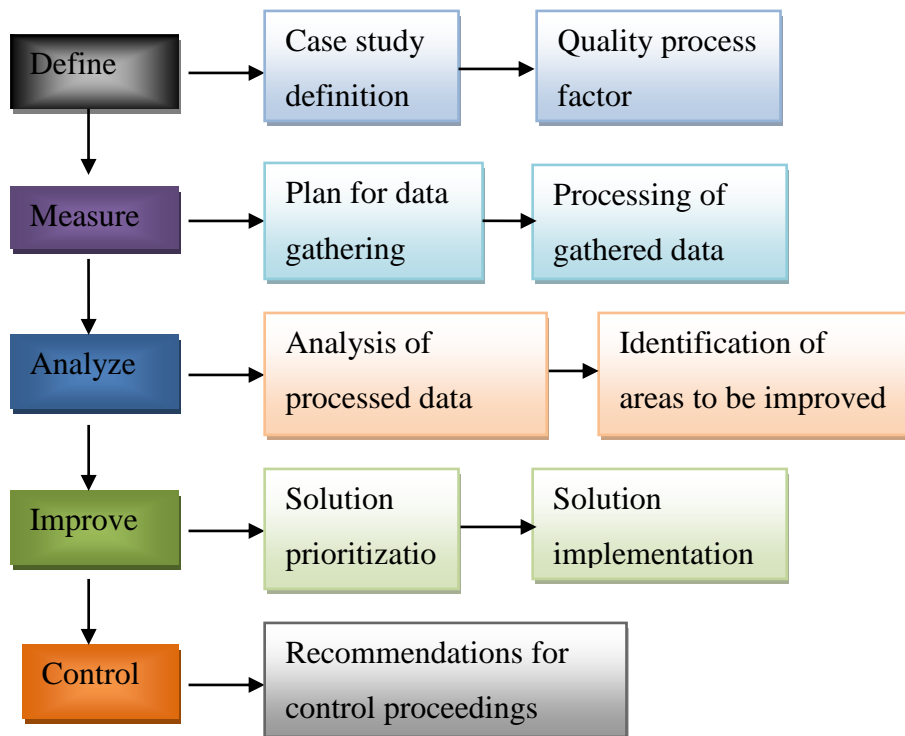


Figure 6: The Six Sigma steps used for the thesis

3.1 Defining the project

The scope of the project was carefully defines by first considering the stakeholders or those who have an interest in the organization and how this project would be of benefit to them. For any given problem to be solved successfully, it is very essential to do care carefully and accurate stakeholder analysis and management. Once the stakeholders were identified and carefully analyze. It was very crucial that the attitudes of the stakeholders with respect to the problem solving were fully understood and this made is easy to define the scope of the entire project. The stakeholders include the government of Ghana, Ghana standards authority, Food and drugs board, operators within the petroleum sector, medium and scale enterprise and University of Vaasa. (Hester, 2015).

In this case study, the define phase seeks to evaluate the areas that need to be improved or carefully check in order to ensure that the organizational performance will be enhanced in order to improve upon the quality of service. This was done by carefully analyzing which areas to improve. When this is achieved, it will not only benefit Ghana standards authority but also give all the stakeholders the confidence in the type of work done.

3.2 Measuring of the variables

The measure phase of the project involves data collection and evaluation to help identify which areas need to be improved in order to improve the quality of service provider to the customers. Based on the definition of the scope of the project, a plan for data gathering was generated.

The variables that were to be measured were carefully considered and questionnaires were generated with the hope of gathering more information on how the process, people, equipment, environment and management can contribute to the quality of service provided.

A bar chart was plotted showing the results from the study and providing a general idea of which area needs to be improved and which areas have the potential value to affect the quality of operations.

3.3 Analyzing the results

Analysis of the data gathered from the questionnaires that were submitted was made. This was to aid in analyzing the performance of each of the variables. This gave an overview of which area needs to be improved upon so as to achieve a more desirable operational excellence.

In the analyze phase, a critical analysis of the data was made and of root cause of lack of high quality performance was made based on the variables that were measured and analyzed. Consequently, there was a brainstorming session to try to find out what made the most impact on the quality of service based on the results from the study.

3.4 Improving performance

Analysis of the data provided the platform to argue on which area needs to be improved upon in order to improve the quality of service provided to customers. Solution identification was the first step taken under the improve phase, this was to find out all the possible solutions that could be assigned to a particular problem.

These solutions are then arranged in order of prioritization based upon the level of the problem and availability of resources to tackle a particular problem. Solutions are then provided with the hope that the necessary procedures or steps will be put in place to address the issues.

3.5 Controlling the entire process

In the control phase of the project, recommendations were given on each measured variables, what the interpretation was from the results, how it affects the quality of service and how this can be solved. Further improvement in overall efficiency can be made by analyzing and improving the efficiency of the various variables that have been measured.

As it was noted in chapter two of this report, the Six Sigma methodology is a closed loop process and therefore should not just end at the end of this study but rather, this study should be conducted periodically and check which areas still needs to be improved.

4 RESULTS ANALYSIS

A total of thirty questionnaires were distributed to the employees working under the metrology division of Ghana standards authority. These employees all work under various department of the division under study namely legal metrology, scientific metrology and industrial metrology. The key areas under investigation were categorized in six sections to find about which aspect needs to be improved in order to ensure an increase in organizational performance. These categories are improvement of employee performance, improvement of working process, equipments and machinery used for calibration, issues regarding working environment, management involvement to quality issues, barriers to achieving organizational strategies.

The employees were given the chance to strongly agree, agree, strongly disagree, disagree and neither agree nor disagrees to a particular answer choice.

4.1 Employees performance

In today's competitive market, improving the quality of employee performance is seen as an intellectual key to the financial performance of any given organization. Employee performance can be defined as the contribution of an employee (directly or indirectly) to the total output of any given organization. (Hatane, 2015)

The research question under this category was to find out which areas needed to be addressed in order to bring out the best out of the employees. In figure 7 below, the areas in blue (A) represent the answer choice to see if employees need further training to enhance their skills, the areas in red (B) represent the answer choice to see if employees need to follow standard working procedures to enhance good results and the areas in green (C) represent the answer choice to see if the division needs more man power.

	A	B	C
Strongly agree	19	21	10
Agree	9	7	13
Strongly disagree	0	0	2
Disagree	0	0	0
Neither agree nor disagree	2	2	5

Table 4: Total number of responds for the study under employee performance

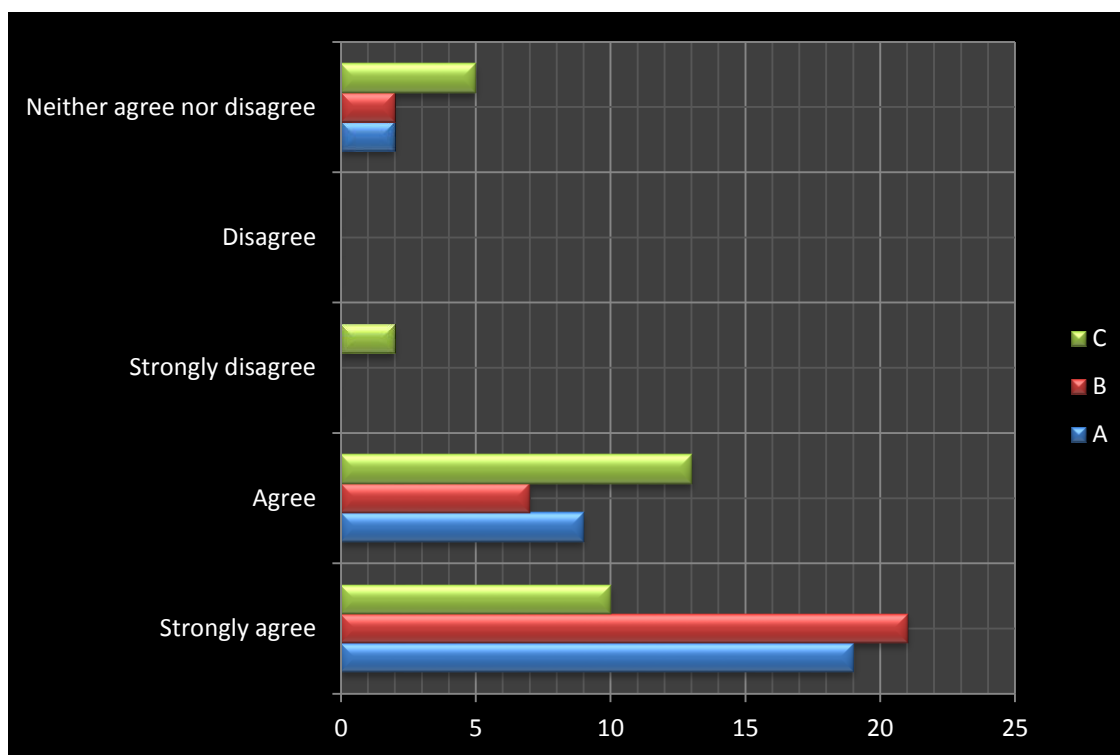


Figure 7: Graphical display of responds for the study under employee performance

4.1.1 Employees need further training to enhance their skills

This is represented by the areas in blue from figure 7 above. A total of 19 which represents 63.33% of the respondents strongly agree that employees need further training to enhance their skills and 9 (30%) of the respondents agree to this statement while 2 respondents were not sure whether to agree or disagree to the statement.

4.1.2 Employees need to follow standard working procedures to enhance good results

This is represented by the areas in red from figure 7 above. The results show a total number of 21 (70%) of the respondents strongly agree that employees need to follow standard working procedures to enhance good results. In addition to this, 7 (23.33%) of the respondents agree to that statement while 2 respondents were not sure whether to agree or disagree to the statement.

4.1.3 The division needs more manpower

This is represented by the areas in green from the figure above. Out of the total number of 30 respondents, 10 respondents strongly agree that the division needs more manpower while 13 (43.33%) of the respondents agree to the statement. However, 2 respondents strongly disagree that the division is in need of more manpower while 5 respondents were not sure whether to agree or disagree to the statement..

4.2 Working process/procedure

In calibration, it is very important to ensure that the right procedure or process is observed during measurement in order to eliminate or at least try to bring to the minimum all error associated with measurement. It is therefore very important that employees adhere to all the necessary procedures or steps during measurement.

The research question under this category was to find out if the right working process is in place and also to see if employees follow these working processes. In figure 8 below, the areas in blue (A) represent the answer choice to see if working procedures are documented and made accessible to all employees who need them, the areas in red (B) represent the answer choice to see if employees need to follow standard working procedures to enhance good results and the areas in green (C) represent the answer choice to see if the documentation of calibration carried out needs to be properly done. Table 2 and Figure 8 below give an overview of the responds that was retrieved from the study.

	A	B	C
Strongly agree	19	0	16
Agree	10	10	10
Strongly disagree	0	6	1
Disagree	1	9	2
Neither agree nor disagree	0	5	1

Table 5: Total number of responds for the study under working process

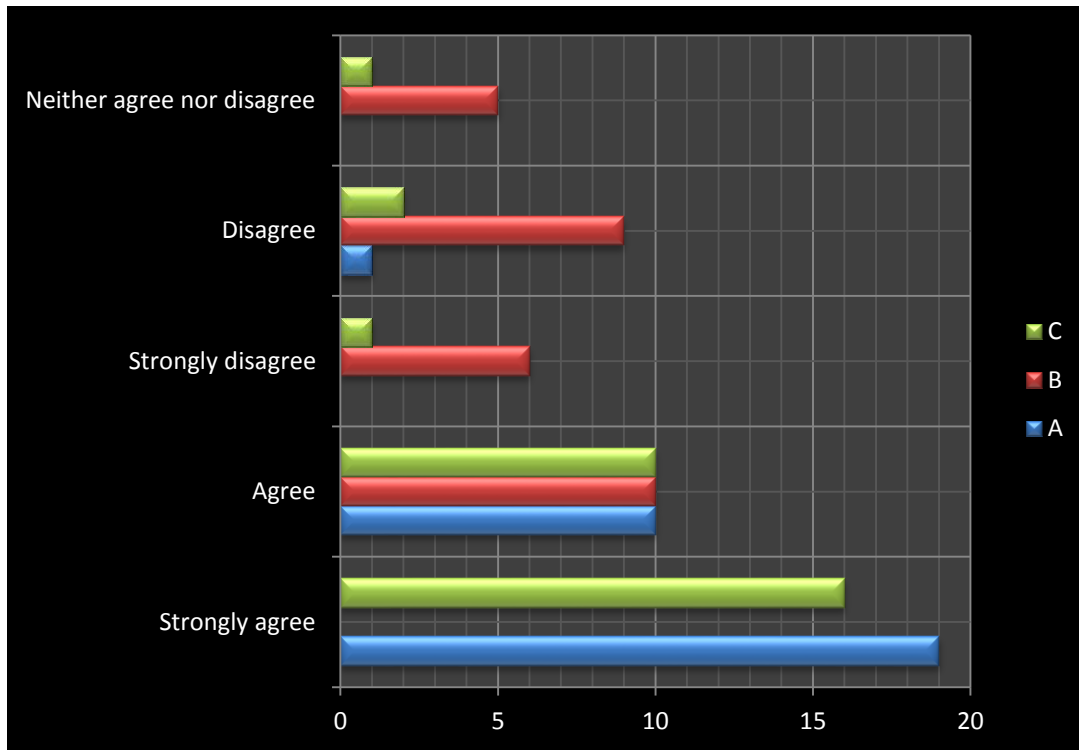


Figure 8: Graphical display of responds for the study under working process

4.2.1 Working procedures must be documented and made accessible to all employees who need them

This is represented by the areas in blue from figure 8 above. The task here was to find out how many respondents believe that the working procedures must be well documented and made accessible to all employees who might need them. 19 (63.33%) of the respondents strongly agree that working procedures must be documented and made accessible to all employees who need them. In addition to this 10 (33.33%) of the respondents agree to this statement. However, 1 respondent disagreed to this statement indicating that working procedures are documented and are accessible to all employees who need them.

4.2.2 Employees do not follow the right working processes or guidelines

This is represented by the areas in red from figure 8 above. The task here was to find out how many respondents believe that employees do not follow the right working processes or guidelines. None of the respondents strongly agree to this statement, nevertheless, 33.33% that is a total of 10 respondents agree that employees do not follow the right working processes.

On the other hand, 6 respondents strongly disagree to this statement indicating that they believe the right working processes are been followed. In addition to this, 9 or 30% of the respondents also disagreed to this statement sharing the same view with those who strongly disagree and they all believe that the right working processes are been followed.

Nevertheless, 16.67% of the respondents fail to agree or disagree to this statement and were not sure if the right working processes or guidelines are carefully observed by the employees.

4.2.3 Documentation of calibration carried out needs to be properly done

This section seeks to find out how many respondents believe documentation of every calibration carried out needs to be done properly so that in the future it will be easy to trace back to the records if the need arises. The results are represented by the areas in green from figure 8 above. 16 (53.33%) of the respondents strongly agree that documentation of calibration carried out needs to be properly done. Furthermore, 10 (33.33%) of the respondents agree to this statement bringing the total number of responds who side with view that records of calibration carried out should be properly documented to 26 (86.67%).

However, 3 respondents did not side view with the statement. Out of this number, 1 respondent strongly disagreed and believes that documentations are properly done whiles 1 respondent was not sure if whether the documentation of the calibrations carried out were properly done or not.

4.3 Equipments or machineries used for calibration

Calibration can be defined as a comparison between a known measurement (the standard) and a unknown measurement using your instrument with the aim of transferring the accuracy of the known measurement (the standard) to the unknown. It is therefore very important to ensure that the equipments or machineries that are used for the calibration are in the best of shape in terms of accuracy and efficiency.

The research question under this section was to find out which areas needed to be addressed in order to find out what to change or issues to address regarding the equipments or machineries used for the calibration exercise. This is section is very important to the study due to the nature of the services the organization renders to the public. Measurements carried out during calibration are expected to be as accurate as possible and this relies heavily on the type of equipments and machineries used. In figure 9 below, the areas in blue (A) represent the answer choice to seeks to find out if there is the need for the division to acquire modern calibration equipments to improve upon the efficiency of the work that is been done. On the other hand, the areas in red (B) represent the answer choice that attempts to find out if the division needs more work forces to be able to meet the demand of work load and not necessarily acquiring modern calibration equipments.

	A	B
Strongly agree	14	10
Agree	13	12
Strongly disagree	0	2
Disagree	2	5
Neither agree nor disagree	1	1

Table 6: Total number of responds for the study under equipments and machineries

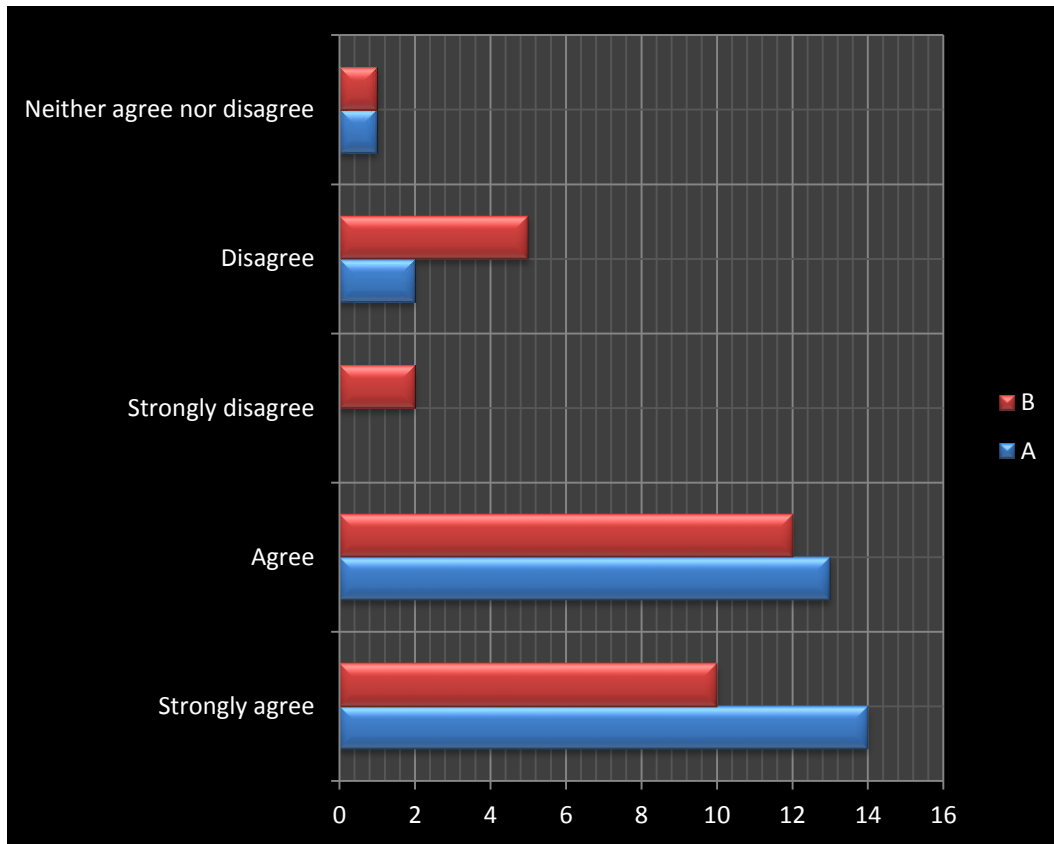


Figure 9: Graphical display of responds for the study under equipments and machineries

4.3.1 The need to acquire modern calibration equipments to improve the efficiency of the work output

The task here was to find out how many respondents believe that the division needs to acquire modern calibration equipments to improve the efficiency of the work carried out. The results from the study are shown in figure 9 and are represented by the areas in blue. Out of the 30 respondents, 14 strongly agree that the division needs to acquire modern calibration equipments to enhance the efficiency of work done.

In addition to this number, 13 respondents also agree and side views to those who strongly agree that the division should acquire modern calibration equipments. This brings the total number of respondents who side view with the acquisition of modern calibration equipments to 27 (90%).

However, 2 respondents did not agree to this view of acquiring modern calibration equipments but believe that what is available currently is enough to enhance the efficiency of work carried out while 1 respondent was not sure whether to agree to the acquisition of modern equipments or not.

4.3.2 The division needs more workforce to be able to meet the volume of work it receives

The results from the study are shown in figure 9 and are represented by the areas in red, the results gives an insight on the view of the respondents on whether the division needs more workforce to be able to meet the volume of work it receives rather the acquiring modern calibration equipments which can enhance the efficiency of the work done.

Out of the 30 respondents, 10 strongly agree that the division needs more workforces in order to meet the volume of work it receives from clients. Furthermore, 12 respondents also agree to this view which brings the total number of respondents who side view that the division needs to deploy more workforces in order to meet to the demand of work to 22 (73.33%).

Nevertheless, other respondents share different view of the issue, 2 of the respondents strongly disagree and believe that the division does not need to deploy more workforces to meet the volume of work received from clients while 5 of the respondents also disagree and share the same view as those who strongly disagree. This brings the total number of respondents who believe that the division does not need to deploy more workforces to meet the volume of work received to 7 (23.33%) while 1 respondent was not sure whether the division needs to deploy more workforce or not.

4.4 Working environment

Many organizations in our modern day fail to understand the importance of working environment for employee job satisfaction and thus lead to a lot of difficulties during their work. Working environment could be categorized in to two main streams such as work and context. Work includes all the different characteristics that the job entails, carried out and completed. It is therefore paramount to ensure that the environment in which all calibrations are carried out meet the required standard. (Maulabakhsh, 2015).

The research question under this section was to find out what needs to be addressed regarding the working environment. Measurements carried out during calibration are expected to be done under certain standard conditions of temperature, pressure and humidity. In addition to this, the general laboratory layout should be more conducive to allow the worker the free space to be able to carry out the calibration exercise.

In figure 10 below, the areas in blue (A) represent the answer choice to seeks to find out if the ambient condition for measurement in the various laboratories needs to be properly checked during measurement. The areas in red (B) represent the answer choice that attempts to find out if every laboratory has an instrument to check for the ambient temperature and humidity before calibration. The areas in green (C) represents the answer choice that is aimed at finding out if there are limited spaces in the various laboratories, which makes working a bit difficult whiles the areas in violet (D) represents the answer choice for finding out if the laboratories must be upgraded in terms of facilities and training to enhance the efficiency and accuracy of calibration results.

	A	B	C	D
Strongly agree	15	0	1	16
Agree	12	3	6	10
Strongly disagree	0	11	4	3
Disagree	1	11	15	1
Neither agree nor disagree	2	5	4	0

Table 7: Total number of responds for the study under working environment

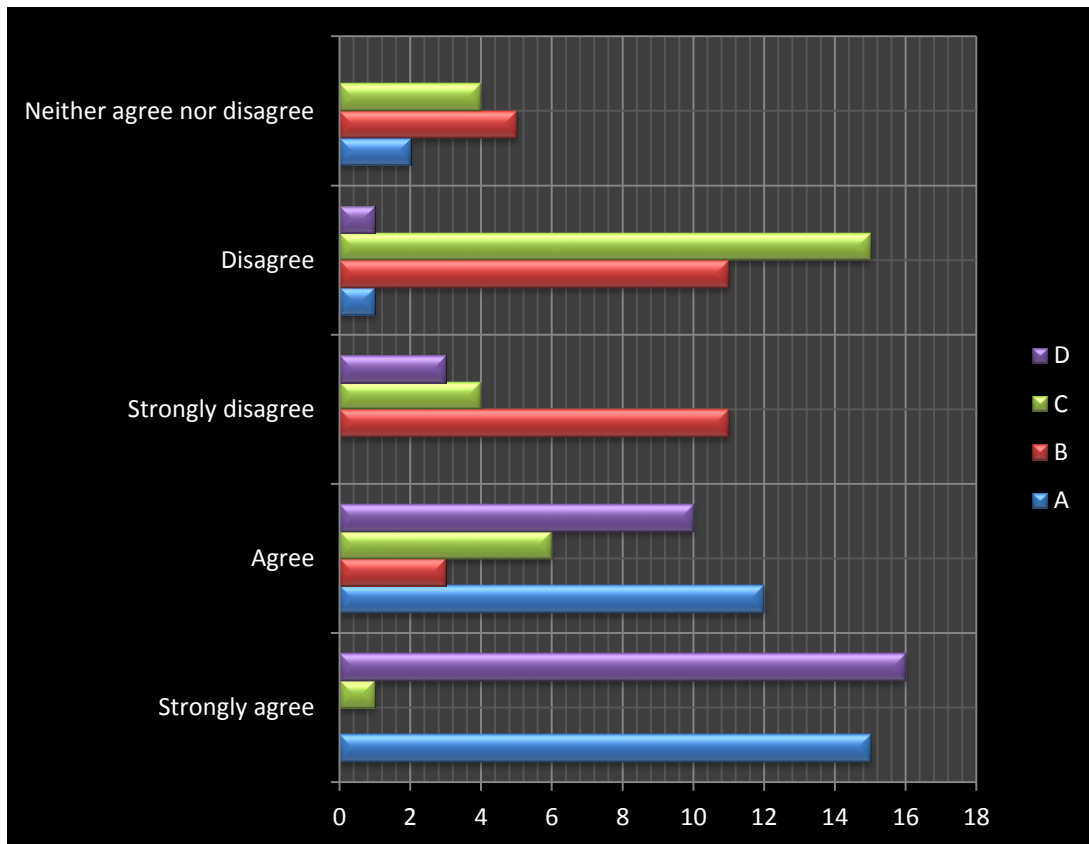


Figure 10: Graphical display of responds for the study under working environment

4.4.1 Ambient conditions for measurement in the various laboratories needs to be properly checked during measurement

The task was to find out how many respondents believe that the ambient conditions for measurement in the various laboratories needs to be properly checked during measurement to ensure that the calibration exercises are conducted under the right temperature, pressure and humidity.

The results from the study are shown in figure 10 and are represented by the areas in blue. A total of 15 respondents strong agree that the ambient conditions should be properly checked when conducting the calibration exercises. In addition to this, 12 of the respondents agree to this issue. This brings the total number of respondents who side view that the ambient conditions need to be check to 27 (90%).

However, 1 respondent disagreed and believed that the ambient conditions do not need to be properly checked whiles 2 of the respondents were not sure whether the ambient conditions needs to be properly checked during a calibration exercise or not.

4.4.2 There are no instruments to check for the ambient temperature and humidity in the various laboratories.

This section seeks to find out if the various laboratories under metrology have the right measuring instruments to measure the temperature and humidity during calibration. The results from the study are shown in figure 10 and are represented by the areas in red.

From the figure, none of the respondents strongly agreed that there are no instruments to check for the ambient conditions in the various laboratories, whiles 3 (10%) of the respondents agree that there are no instruments to check for the ambient conditions in their laboratory.

However, 11 (36.67%) of the respondents strongly disagreed to this and believe that there are instruments in the various laboratories to measure the ambient conditions during calibration exercise. In addition to this, 11 of respondents also disagree and side view with those who strongly disagree.

This brings the total number of respondents who believe that that there are instruments in the various laboratories to measure the ambient conditions during calibration exercise to 22 (73.33%) while 5 of the respondents were not sure whether there are instruments to check for the ambient condition or not.

4.4.3 There are limited spaces in the various laboratories, which makes working a bit difficult

Like any working environment, there must be enough room to contain the working and the machineries used for working. This section seeks to find out if the laboratories are conducive enough to ensure that workers have the comfort and space to perform their task. The results from the study are shown in figure 10 and are represented by the areas in green.

The total number of respondents who believe that there are limited spaces in the various laboratories which makes work a bit difficult for them is 7 (3.33%). On the other hand, 4 of the respondents strongly disagree and believe that there is enough space in the various laboratories to carry out the calibration exercises.

In addition to this number, 15 of the respondents also disagree and are in agreement to those who strongly disagree. This brings the total number of respondents who believe that that there is enough space in the various laboratories to carry out the calibration exercises to 19 (63.33%) of the respondents.

4.4.4 The laboratories must be upgraded in terms of facilities and training to enhance the efficiency and accuracy of calibration results

The change in technology and customer demand these days calls for constant improvement on the path of organizations to meet up to the daily challenge. This section of the study seeks to find out if the various laboratories need to be upgraded to meet modern standards in terms of facilities and training to enhance the efficiency and accuracy of the calibration. The results from this study are shown in figure 10 and are represented by the areas in violet.

A total number of 16 respondents strongly agree that the various laboratories need to be upgraded in terms of facilities and training to enhance the efficiency of work done. Furthermore, 10 of the respondents also agree to this statement and this brings the total number of respondents who believe that the various laboratories must be upgraded to 26 (86.67%).

Contrary to those who agree that the laboratories need to be upgraded, 3 of the respondents strongly disagree and believe that the various laboratories do not need to be upgraded while 1 respondent disagrees and side view with those who strongly agree. This brings the total number of respondents who believe that the laboratories do not need upgrading to 4 (13.33%)

4.5 Management involvement to the quality of work output

In the document presented by the International Organization for Standardization (ISO) which introduced the eight quality management principles on which the quality management system standards of the ISO 9000 series are based it was stated that “*Leaders establish unity of purpose and direction of the organization. They should create and maintain the internal environment in which people can become fully involved in achieving the organization’s objectives.*”

Among the principles of quality improvements, it is expected that management needs to get involved in issues regarding the quality of work. This is an effective way to ensure that the quality of work within any given organization is kept to the standard. (Oakland, 2015). The research question under this section was to find out how management gets involved in quality of work and response to quality issues.

In figure 10 below, the areas in blue (A) represent the answer choice to seeks to find out if management needs to get more involved in quality issues regarding the nature and output of the work whiles the areas in red (B) represent the answer choice that attempts to find out if management needs to quickly address problems presented to them by the employees. The table and figure below gives an overview or summary of the data that was collected under this section of the study.

	A	B
Strongly agree	16	17
Agree	13	10
Strongly disagree	0	0
Disagree	0	3
Neither agree nor disagree	1	0

Table 8: Total number of responds for the study under management involvement to quality issues

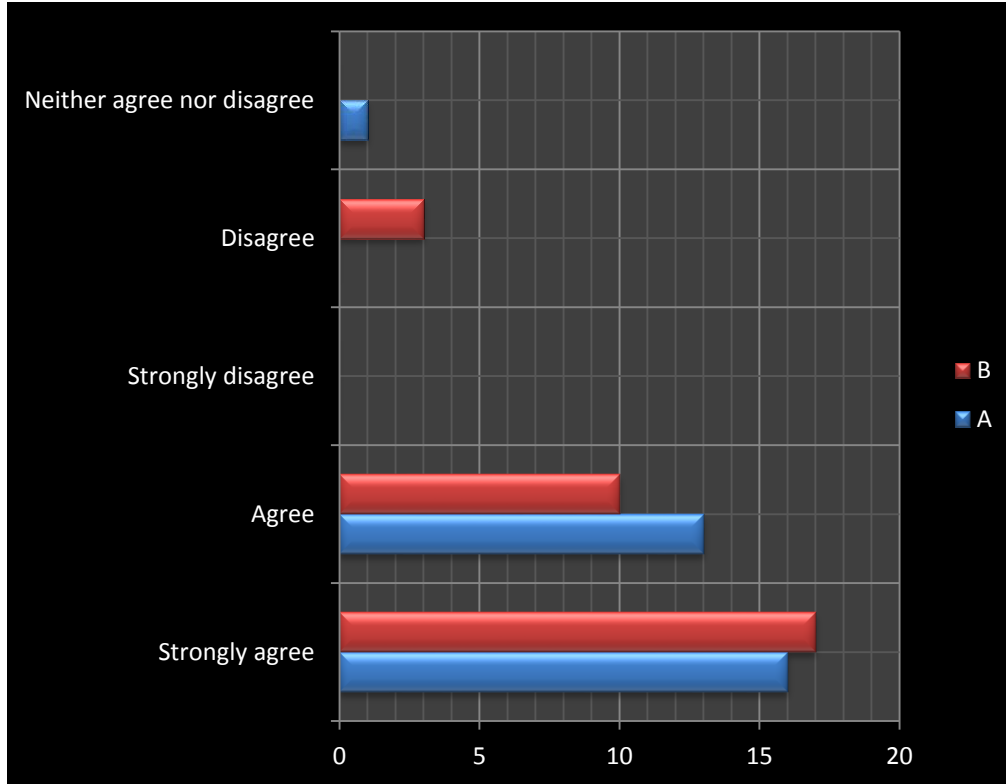


Figure 11: Graphical display of responds for the study under management involvement to quality issues

4.5.1 Management needs to get more involved in quality issues regarding the nature and output of the work.

The goal under this section of the study was to find out if management needs to get more involved in quality issues regarding the nature and output of the work done. This is represented by the areas in blue (A) in figure 11.

Out of the total of 30 respondents, 16 (53.33%) strongly agree that management needs to get more involved in quality issues. In addition to this number, 13 (43.33%) of the respondents agree that management needs to get more involved in quality issues. This brings the overall number of respondents who believe that management involvement in needed to 29 (96.67%). However, 1 (3.33%) respondent was not sure if management needs to get more involved in quality issues regarding the nature and output of work or not.

4.5.2. Management need to quickly address problems presented to them by the employees

The goal under this section of the study was to find out if management needs to quickly address problems presented to them by the employees. This is represented by the areas in red (B) in figure 11.

A total of 17 (56.67%) out of the 30 respondents strongly agree that management needs to quickly address problems presented to them by the employees. Furthermore, 10 (33.33%) of the respondents agree that management needs quickly address problems presented to them by the employees. This brings the overall number of respondents who believe that management needs quickly address problems presented to them by the employees to 27 (90%).

However, 3 (10%) respondent disagree to this statement and believe that management responds quickly when problems are presented to them by the employees.

4.6 Barriers that hinder the achievement of strategic objectives

The research question under this section was to find out the barriers that hinder the organization from achieving its strategic objectives. There are four barriers that hinder any organization from achieving its strategic objectives and they include the vision barrier, the management barrier, people barrier and resource barrier. (Oakland, 2015).

In figure 12 below, the areas in blue (A) represent the answer choice to seek to find out if the vision barrier (very few of the workforces understands the organization's visions and strategies) is one of the barriers the hind the implementation of the organization's strategic objectives.

The areas in red (B) represent the answer choice that attempts to find out if the management barrier (executive teams or management spend less than one hour per month discussing

about the division's strategies) is one of the barriers that hinder the implementation of the organization's strategic objectives.

The areas in green (C) represent the answer choice that is aimed at finding out if resource barrier (resources are not linked to achieving strategic objectives) is one of the barriers that hinder the implementation of the organization's strategic objectives.

The areas in violet (D) represent the answer choice for finding out if the people barrier (management do not link incentives that encourage workers in attaining strategic objectives) is one of the barriers that hinder the implementation of the organization's strategic objectives.

	A	B	C	D
Strongly agree	4	5	4	11
Agree	12	11	13	15
Strongly disagree	4	3	5	1
Disagree	8	6	5	3
Neither agree nor disagree	2	5	3	0

Table 9: Total number of responses for the study under barriers to achieving strategic objectives

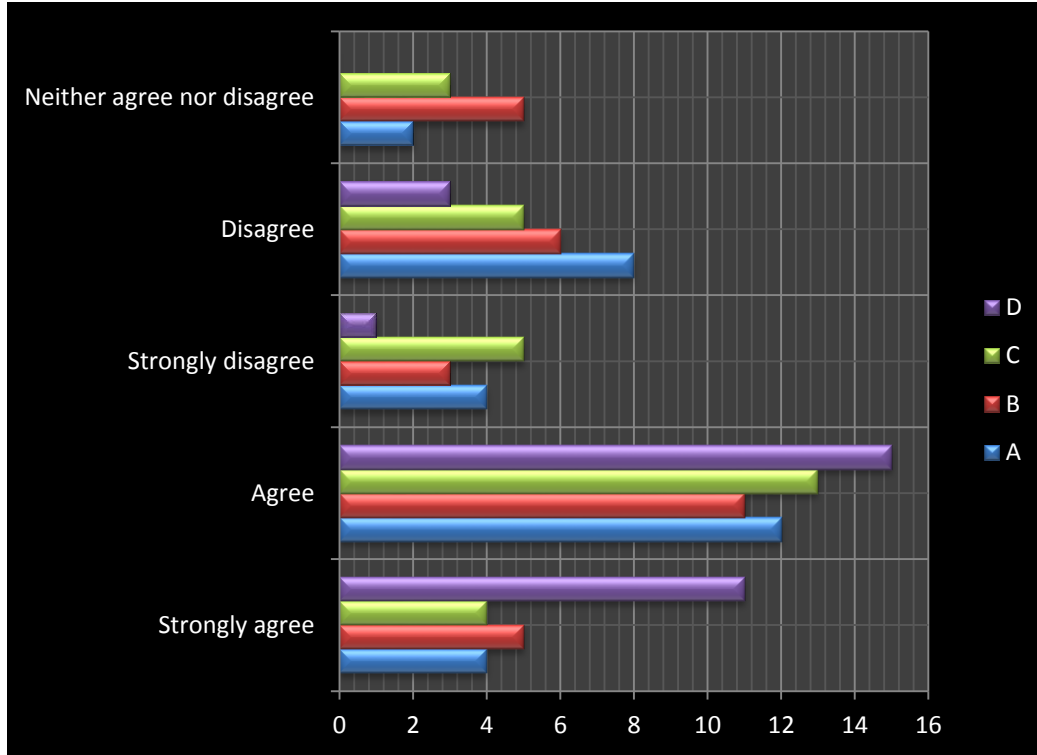


Figure 12: Graphical display of responds for the study under barriers to achieving strategic objectives

4.6.1 Vision barrier

This section of the question was targeted at finding out if the employees or the working force really understand the vision of the organization. According to Oakland (2015), most of the working forces in many organizations do not understand the vision of the organization and this makes it very difficult to implement and achieve any strategic goal or objective set by the organization. The results from this section of the study are represented by the areas in blue (A) in figure 12 above.

According to the figure above, 4 of the respondents strongly agree that very few of the workforces understand the organization's visions and strategies thereby making it difficult for the organization to implement its strategic objectives. In addition to this number, 12 of

the respondents agree, this brings the total number of respondents who believe that very few of the workforces understand the organization's visions and strategies to 16 (53.33%).

However, 4 of the respondents strongly disagree to this and believe that the employees understand the organization's visions and strategies. Furthermore, 8 of the respondents also disagreed to and they also believe that the workforces understand the organization's visions and strategies. This brings the total number of respondents who believe that the workforces understand the organization's visions and strategies to 12 (40%).

4.6.2 Management barrier

The question was aimed at finding out if executive teams or management spend less than one hour per month discussing about the division's strategies. According to Oakland (2015), for any organization to be able to successfully implement its strategic objectives, management needs to spend some time every month discussing the strategies and objectives to the workforce. The results from this section of the study are represented by the areas in red (B) in figure 12 above.

From figure 12 above, 5 out of the total of 30 respondents strongly agree that executive teams or management spend less than one hour per month discussing about the division's strategies. Furthermore, 11 of the respondents agree to this and believe that executive teams or management spend less than one hour per month discussing about the division's strategies.

Contrary to this, 3 respondents strongly disagree and believe that the executive teams or management actually spends time each month to discuss about the division's strategies. In addition to this, another 6 respondents also agree that the executive teams or management actually spends time each month to discuss about the division's strategies. This brings the total number of respondents who believe that the executive teams or management actually spends time each month to discuss about the division's strategies to 9 as against a total number of 16 who do not side view to this claim.

4.6.3 Resource barrier

According to Oakland (2015), most organizations do not link linked to achieving strategic objectives. Therefore, this section of the study was channeled at finding out if the organization actually faces this type of problem. The results from this section of the study are represented by the areas in green (C) in figure 12 above.

Out of the total of 30 respondents, 4 of them strongly agree that resources are not linked to achieving strategic objectives whiles 13 of the respondents agree to this. This brings the total number of respondents who believe that the organization needs to link its resources to achieving strategic objectives to 17 (56.67%).

On the other hand, 5 of the respondents strongly disagree and believe that resources are linked to achieving strategic objectives. In addition to this, another 5 respondents also disagree and side view with those who strongly disagree. This brings the total number of respondents who believe that resources linked to achieving strategic objectives to 10 (33.33%).

4.6.4 People barrier

According to Oakland (2015), it is important for management do not link incentives that encourage workers in attaining strategic objectives. This section of the study was seeks to find out if the organization actually fulfill this principle that helps to achieve its strategic objective. The results are shown in figure 12 above and are represented by the areas in green (D).

A total of 11 respondents strongly agree that management do not link incentives that encourage workers in attaining strategic objectives. Furthermore, 15 of the respondents also agree that management do not link incentives that encourage workers in attaining strategic objectives.

Nevertheless, 1 respondent strongly disagreed with this and believe that management actually link incentives that encourage workers in attaining strategic objectives. In addition to this number, 3 of the respondents also disagree and side view with those who strongly disagree. This brings the total number of those who believe that management link incentives that encourage workers in attaining strategic objectives to 4 (13.33%).

5 DISCUSSION OF RESULTS

In chapter 4 of the report, the results of the study was analyzed and it covers the employee performance, working process, equipments or machineries used for calibration, working environment, management involvement to quality of work output and barriers that hinder the achievement of strategic objectives.

In this chapter, a detail discussion of the results will be made to find out what the implications of the responds from the study actually means and to give an overview of which areas need to be addressed based on the results from the study.

5.1 Issues on employee performance

In order to find out how the organization can bring out the best out of its employees, certain areas must be addressed to resolve this issue. The results from table 4 and figure 7 gave a detail view of what the respondents felt was the need to tackle regarding the issue of employee performance. The first area was to find out if the employees need further training to enhance their skills; the second was to find out if the employees need to follow standard working procedures in order to enhance good results and the third was to find out if indeed the division needs more skilled labor in order to ease the work load on the employees.

The results from table 4 and figure 7 are evident that measures need to be put in place to tackle the issue of employee performance. A total of 19 (63.33%) of the respondent strongly agree that employees need training to enhance their skills whiles 9 (30%) of the respondents agree to this as it was seen in chapter 4. In order to bring the best out of the employees, they need to have more training in order to improve upon their skills.

According to the results, the root cause of why the organization is not improving in terms of employee performance can be traced to lack of training programs for the employees. In order to tackle this issue, the organization should create some training programs aimed at improving the skills level of the employees.

In addition to finding out if the employees need further training; the next question was to find out if employees need to follow standard working procedures in order to enhance good results. From the results in table 4 and figure 7, a total of 21 (70%) of the respondent strongly agree that employees need to follow standard working procedures in order to enhance good results. Furthermore, 7 (23.33%) of the respondents agree to this as it was seen in chapter 4.

The results from this section gives an indication that in order to bring the best out of the employees, one of the solutions is to ensure that the employees follow the right or standard working process. This would help them to eliminate those small errors that might arise during the calibration exercise. Irrespective of how experienced one is in the job, the importance of following the standard working process should be stressed upon in order to improve the efficiency of the calibration exercise.

The last task under this section was to find out if the division needs more manpower in order to release the stress or workload on the employees to ensure that they carry their task effectively. From the results in table 4 and figure 7, a total of 10 (33.33%) of the respondent strongly agree that the division needs more manpower (labor force). In addition to this, 13 (43.33%) of the respondents agree to this as it was seen in chapter 4. This brings the total percentage of respondent who think that an increase in the number of manpower could help in achieving the desired quality to 76.66%.

This shows that the division needs to look into its workforce and find out areas where more labor is needed in order to improve upon the work that is been done. It is very important to have the right number of people to handle any given work so that you do not put pressure on the workforce. When this is done, it could help eliminate most of the human error that comes as a result of stress during calibration.

5.2 Issues on working process/procedures

This section of the project seeks to find out if the right procedures or processes for carrying out any given calibration exercises are duly observed and to also find out if employees have access or are aware of such processes. The results from table 5 and figure 8 gave a detail overview of what the respondents felt was the need to tackle regarding the issue of working processes within the division.

The first area was to find out if working processes have been documented and made accessible to all employees, the second area was to find out if employees actually follow the right working process and the third area was to find out if documentation of all calibrations carried out is properly done.

According to the result from the study as presented in figure 8, 19 (63.33%) of the respondent strongly that working procedures must be documented and made accessible to all the employees. In addition to this number, 10 (33.33%) of the respondent also agree to this view. In all, a total of 29 (96.66%) were of the view that the department needs to document all the working procedures and ensure that the employees have access to them in order to improve and eliminate certain errors during measurements.

Furthermore, the question on whether employees follow the right working process was also presented in figure 8 and according to the results, 10 (33.33%) of the respondents agree to that employees need to follow the standard or the correct working procedure. On the other hand, 15 (50%) of the respondents believe that employees are following the correct procedures for calibration. This is an indication that employees majoring of employees believe that the follow the correct working procedures and that is actually not a factor to be considered as to what will prevent the organization from progressing in terms of its performance.

5.3 Issues on equipments/machineries used for calibration

As stated in the previous chapter, the task here was to find out if indeed there is a need to tackle the issue regarding the equipments that are used to carry out the calibration exercise in the department. The first task was to find out if the division needs to acquire equipments that are more effective and efficient and the second task was to find out if the division needs more labor other than acquiring more machines/equipment.

Out of the 30 respondents, 14 (46.67%) strongly agree that the division needs to acquire modern calibration equipments to enhance the efficiency of work done. In addition to this number, 13 (43.33%) of the respondents also agree and side views to those who strongly agree that the division should acquire modern calibration equipments. This brings the total number of respondents who side view with the acquisition of modern calibration equipments to 27 (90%).

This gave a very strong indication that the division needs to acquire calibration equipments that are effective and efficient than the ones currently in used. For the division to see any progressive change in the quality of work output, the division needs to acquire equipments that meet modern standards in terms of effectiveness and efficiency. This is evident from the results in table 6 and figure 9 respectively.

The second task was to find out if the division needed more labor force in order to meet the volume of work it receives rather than acquiring more machines. Out of the 30 respondents, 10 (33.33%) strongly agree that the division needs more workforces in order to meet the volume of work it receives from clients. In addition to this number, 12 (40%) of the respondents also agree to this view which brings the total number of respondents who side view that the division needs to deploy more workforces in order to meet to the demand of work to 22 (73.33%).

The results from this section of the studies gave clear indication that in order for the division to see any progressive change in the quality of work output, then the division

should acquire calibration equipment that are more effective and more efficient than the one currently used. Furthermore, the division needs to assess and see if indeed more labor force is needed in order to ease the pressure of work load on its employees. This is very important because when the workload is more employees are put under pressure and stress and this could lead to certain human error during any given calibration exercise. It is therefore important to address these issues.

5.4 Issues on working environment

This part of the study seeks to address the issues of working environment which is very important in any calibration exercise. The first task was to find out if the ambient condition for measurement in the various laboratories needs to be properly checked during measurement. The second was to see if every laboratory has an instrument to check for the ambient temperature and humidity before calibration. The third task was to find out if there are limited spaces in the various laboratories and the fourth task was to find out if the laboratories must be upgraded in terms of facilities and training to enhance the efficiency and accuracy of calibration results.

The results from the study are shown in table 7 and figure 10 respectively. Under the first task, a total of 15 (50%) of the respondents strongly agree that the ambient conditions should be properly checked when conducting the calibration exercises. In addition to this, 12 (40%) of the respondents agree to this issue. This brings the total number of respondents who side view that the ambient conditions need to be checked to 27 (90%). This is a clear indication that employees need to check that the standard conditions for measurement in terms of temperature and pressure (ambient conditions) is met before carrying out any calibration exercise in order to ensure the accuracy of the results.

The second task was to find out if every laboratory has an instrument to check for the ambient temperature and humidity before calibration. From the results, none of the respondents strongly agreed that there are no instruments to check for the ambient

conditions in the various laboratories, while 3 (10%) of the respondents agree that there are no instruments to check for the ambient conditions in their laboratory.

However, 11 (36.67%) of the respondents strongly disagreed to this and believe that there are instruments in the various laboratories to measure the ambient conditions during calibration exercise. In addition to this, 11 (36.67%) of respondents also disagree and side view with those who strongly disagree. This brings the total number of respondents who believe that there are instruments in the various laboratories to measure the ambient conditions during calibration exercise to 22 (73.33%). This shows that the division has provided every laboratory with the instrument to check for the ambient condition. In the first task it was observed that majority of the respondents actually agree that there is a need for employees to check for the ambient condition before calibration commences. The right instruments are there for that to be done and hence the division needs to echo that to the employees.

The third task was to address the issue of working space in the various laboratories. In this regard, the total number of respondents who believe that there are limited spaces in the various laboratories which makes work a bit difficult for them is 7 (3.33%).

On the other hand, 4 (13.33%) of the respondents strongly disagree and believe that there is enough space in the various laboratories to carry out the calibration exercises. In addition to this number, 15 (50%) of the respondents also disagree and are in agreement to those who strongly disagree. This brings the total number of respondents who believe that there is enough space in the various laboratories to carry out the calibration exercises to 19 (63.33%). From the results, it can be seen that majority of the respondents believe that there is enough space for them to carry out any calibration they do, hence are able to work normally.

The final task under this section was to find out if the various laboratories need to be upgraded in terms of facilities and training to enhance the efficiency of work done. A total number of 16 (53.33%) of the respondents strongly agree that the various laboratories need

to be upgraded in terms of facilities and training to enhance the efficiency of work done. Furthermore, 10 (33.33%) of the respondents also agree to this statement and this brings the total number of respondents who believe that the various laboratories must be upgraded to 26 (86.67%). Contrary to those who agree that the laboratories need to be upgraded, a total number of 4 (13.33%) of the respondents do not believe that the laboratories needs upgrading. The results from the study shows that the division needs to address this issue and see how best they can put resources together in order to help upgrade the various laboratories to make the work more effective and efficient.

5.5 Issues of management involvement to quality of work output

This section of the study seeks to find out if management is fully involved or active on issues regarding quality of work. The first task was to find out if management needs to get more involved in quality issues regarding the nature and output of the work and the second question was find out if management needs to quickly address problems presented to them by the employees. The results from this study are shown in table 8 and figure 11 respectively.

A total number of respondents who strongly agree and those who agree that management needs to get more involved in quality issues regarding the work carried out were 29 (96.67%) out of the entire pollution size of 30 respondent. This gave a very strong indication and lot of concern about management involvement to quality of work output. This is however not translated or reflected in other aspects of the study such as employee performance, working environment, working procedures and the rest. If management was fully involved, some of these issues would have been identified and rectified immediately.

The second task as stated above as to find out if management need to address issues brought before them by the employees on time. A total of 17 (56.67%) out of the 30 respondents strongly agree that management needs to quickly address problems presented to them by the employees. Furthermore, 10 (33.33%) of the respondents agree that

management needs quickly address problems presented to them by the employees. This brings the overall number of respondents who believe that management needs quickly address problems presented to them by the employees to 27 (90%).

According to both results from this section of the study, it shows that management really need to get themselves fully involved on quality issues in the division if they really desire to see any progressive change. When management is fully involved it is expected that they would be able to encourage and put in all the necessary measures in place to ensure progressive change and encourage good and quality practice in the division.

5.6 Issues on barriers that hinder the achievement of strategic objectives

Every organization has its own ways of implementing certain strategic objectives for the progress of the organization. This section of the study seeks to address the barriers that hinder the division from achieving its strategic goals. The first task was to find out if the vision barrier (very few of the workforces understands the organization's visions and strategies) is one of the barriers the hind the implementation of the organization's strategic objectives. The second was to find out if management barrier (executive teams or management spend less than one hour per month discussing about the division's strategies) is one of the barriers the hind the implementation of the organization's strategic objectives. The third was to check if resource barrier (resources are not linked to achieving strategic objectives) is one of the barriers the hind the implementation of the organization's strategic objectives and the forth was to find out if the people barrier (management do not link incentives that encourage workers in attaining strategic objectives) is one of the barriers the hind the implementation of the organization's strategic objectives.

According to the results shown in table 9 and figure 12 respectively, a total number of 16 (53.33%) respondents who believe that very few of the workforces understand the organization's visions and strategies. However, 12 (40%) of the respondents believe that the workforce fully understands the visions and strategies of the division. From the results,

majority of the respondents are of the view that the employees do not understand the vision and strategies of the division; hence management should try to break this barrier by educating the employees about the vision and strategies of the division.

The second task was to find out if management barrier is one of the barriers that hinder the organization from achieving its strategic objectives. A total of 16 (53.33) of the respondents agree to this and believe that executive teams or management spend less than one hour per month discussing about the division's strategies (management barrier).

Contrary to this a total number of 9 (30%) respondents believe that the executive teams or management actually spends time each month to discuss about the division's strategies. With the majority of the respondents having the view that management spend less than one hour per month discussing about the division's strategies, it is therefore paramount that management would reconsider and find a way to breach this gap.

The third task was to find out if resource barrier is one of the possible barriers that hinder the division from achieving its strategic objectives. A total number of 17 respondents (56.67%) believe that the organization needs to link its resources to achieving strategic objectives. However, a total of 10 (33.33%) of the respondents believe that resources are linked to achieving strategic objectives.

Considering the results and the view of the majority of the respondents, managements should look into how they allocated resources within the division. Resources allocation should be aimed at improving the quality of work and achieving the objectives of the division.

The forth task was to find out if people barrier is one of the barriers that hinder the organization from achieving its strategic objectives. A total of 26 (86.67%) respondents believe that management does not link incentives that encourage workers in attaining strategic objectives.

Nevertheless, 4 (13.33%) of the respondents believe that management link incentives that encourage workers in attaining strategic objectives. According to the results from the study, it would be expected that management should try and link some incentives that would boost or encourage the employees to try and strive hard in order to help achieve the objective strategies of the division.

6 RECOMMENDATION

Considering the importance of quality and continuous improvement in any given organization and the sensitivity of the nature of the work carried out by the division under study, it is therefore important that the areas that have been reviewed or studied should be given much attention. To this effect, certain recommendations have been made after a careful analysis of the results and discussions to find out how the division can implement changes to improve upon the quality of services in the division.

Recommendation was given based on the availability of resources to tackle the issue at hand. The figure below gives an overview in hierarchical order of how changes should be implemented based on the study that was conducted.

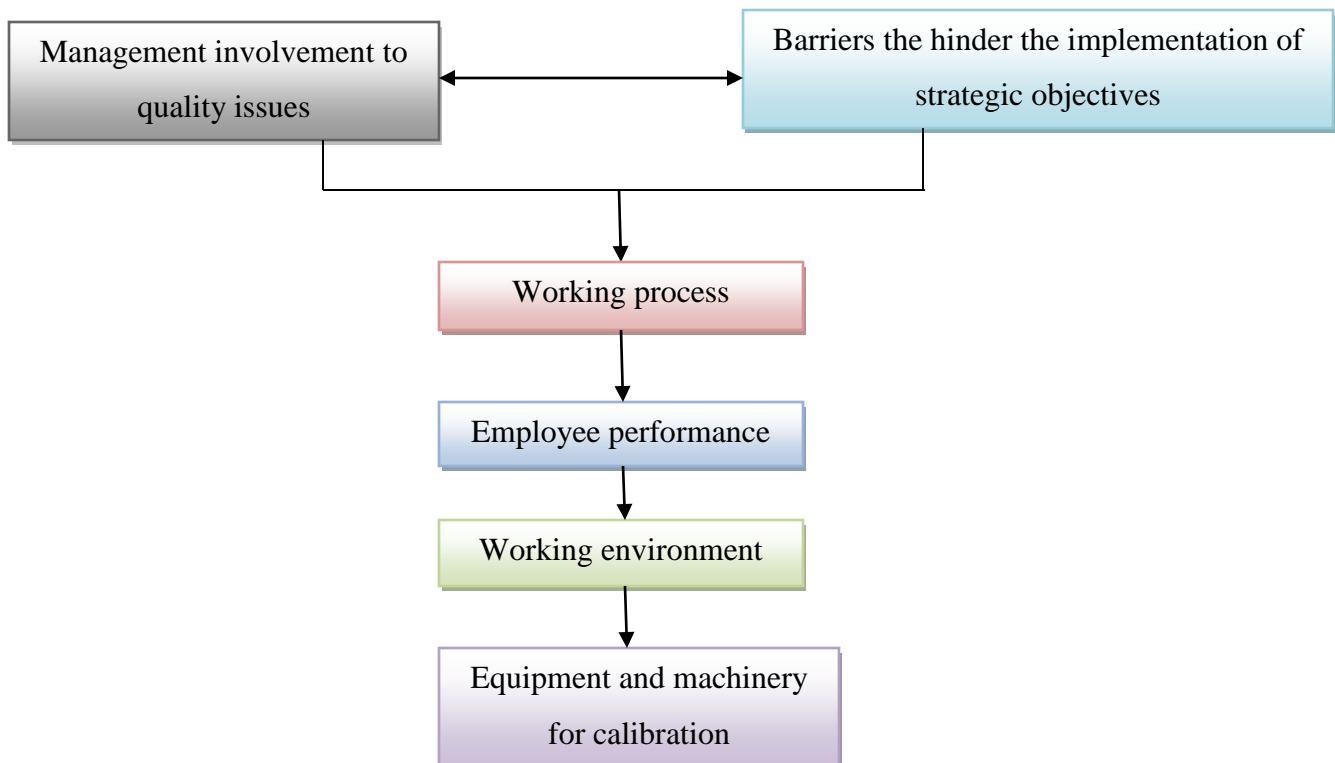


Figure 13: Hierarchical order of recommendation of the variables under study

6.1 Management involvement to quality issues

Management involvement to quality issues has been placed on top of the hierarchy for two reasons. Firstly, it is essential and very important that management must get themselves involve in quality issues if they expect any improvement or progress within the organization. According to the results from the study seen in the early chapters, there is a clear indication that employees feel management has not been actively involve anyway to tackle and help improve the quality of service that is been provided by the organization. It is therefore recommended that management should try and be actively involved to help improve the quality of work within the division.

Secondly, it those not require much resource to get management to partake actively in quality issues. It is therefore recommended that management should try to hold a meeting to see how best they can position themselves in this arena to ensure that certain policies are implemented and monitored regular for the quality and continuous improvement of the division.

6.2 Barriers that hinder the implementation of strategic objectives

This was placed on the same level as the management involvement to quality issues because both require minimum resources to implement. Four barriers have been identified and placed under study. The recommendations given for each of the barriers are as follow

6.2.1 The vision barrier

The barrier here is that very few of the workforce understands the organization's visions and strategies and therefore do not know in which direction the organization of division is heading towards. It is therefore highly recommended that management should implement a strategy where they will be having general meetings and seminars with the employees to let them be aware of the vision, strategies and targets of the organization.

This will help the employees have a clear overview of the task ahead of them and what is expected of them. When they have a clear view of the strategies and visions, they can also make their own contributions for the progress of the division. It is therefore recommended that management should try and let the employees in the division be aware of the strategies and how they are expected to work towards achieving those strategies and point out clear what the vision or target is to the employees.

6.2.2 The management barrier

The barrier here is that executive teams or management spend less than one hour per month discussing about the division's strategies to the employees. This might sound boring but it is very important for management to do. Discussion of the strategies of the division is key to the progress of the division in the sense that some the employees who work in the field could give certain recommendations based on their experience. By doing so, employees feel they are part of the decision making process and they will be willing to work hard to achieve the goals set in the strategies.

It is therefore recommended that management should try and hold meetings periodically to assess and discuss the division's strategies, visions and objectives to the employees and also try and ask for suggestions from the employees.

6.2.3 The resource barrier

The barrier here is that resources are not linked to achieving strategic objectives. The results from the study shown in the previous chapters indicate that employees feel resources are not linked to achieving strategic objectives. It is therefore recommended that management should try to look into the issue and find out what resources are available and how best they can channel those resources to fit or match up with the right objective.

This area requires feature and careful analysis by management in the sense that the study did not focus on exactly what resources are available and how they can match which of the strategies. Therefore management should try and map a strategy of finding out what strategies they want to implement and how or what resources will best fit those strategies.

6.2.4 The people barrier

The barrier here is that management does not link incentives that encourage workers in attaining strategic objectives. In any given organization, it is very important to keep the employees highly motivated so that they can carry out their task effectively. Incentive is one of the many ways to keep employees motivated to work hard and give in their best contribution in achieving organizational goal.

It is therefore recommended that management should try and come up with an incentive program however small it may be in order to encourage employees and give in their best performance and contributions to achieve organizational goals and objectives.

6.3 Working process

Working process is key and essential in calibration due to the nature and sensitivity of any measurement that is to be carried out. It is therefore important that employees follow the required procedures for any given calibration exercise. According to the results from the study, it is recommended that head of various departments under the Metrology division must ensure that employees have in their possession all the need guidelines and procedures to carry out their daily task with according to the standards that is been used by the organization. This would go a long way to help eliminate certain unseen errors during any given calibration exercise and it would add up to the quality of work output in the division.

Furthermore, management (heads of department) should try and organize a meeting periodically to keep reminding the employees of the need to follow the right working

standards however experience they may be in the field. Constant remind would let the employee ne fully aware of the repercussion that might follow if anything goes wrong in their field of service and hence would keep the employees on alert on why it is very important to follow the correct working processes.

In addition to this, management must also ensure that after every calibration, documentations of all the calibrations made must properly kept for future reference as there could be any uncertainty that might require going back to get prove of what was made in the past to justify any future decisions.

6.4 Employee performance

Every organization needs to ensure that its human resource is well equipped with the needed skills to handle it day to day activities. According to the results from the study, many of the respondents were of the view that employees need further or more training in order to enhance their skills. The Metrology division has over the years been sending employees for training overseas to learn more about calibration. This is a good step towards enhancing their skills. It is therefore recommended that whenever these representatives return from their training, they should try and share whatever knowledge they have acquire to their colleagues. In addition to this, management should also try to organize seminars and workshops for the employees were they can invite expects from other countries to share they knowledge and enhance the skills of its employees.

Following the right way of working can help eliminate some human errors associated with measurement. It is therefore recommended that employees follow the correct and standard way of working to help enhance the efficiency of the work that they do. Management need to stress on the importance of following the required or standard way of working during any calibration exercise.

According to the results from the study, respondents believe that there is a need for the division to get more labor force to help assist with the work. It is therefore recommended

that management should try and assess the situation and see if there is a need to get more people. This would go a long way to help reduce stress and ensure effective and efficient way of working and would enhance the overall quality of the work in the division.

6.5 Working environment

The results from the study shows that majority of the respondents agree that there are instruments in the various laboratory to check and measure for the ambient conditions during measurement. Furthermore, respondents also agree that the space in the laboratory is convenient enough to accommodate any kind of calibration exercise in the department. However, it is recommended that a system is put in place to ensure that the measurements of the ambient conditions are done and that also find ways to ensure that the laboratories are even more convenient than they are now.

Though there are measuring instruments in the various laboratories, many of the respondents agree that employees need to properly check for the measurement of the ambient conditions (temperature, humidity and pressure) and record them before any calibration exercise. It is therefore recommended that employees are been reminded on the importance and contributions of the ambient conditions to the calibration exercises and should be encouraged to carry out these measurements before embarking on any calibration.

Majority of the respondents agree that there is a need for the various laboratories to be upgraded in terms of facilities and training to enhance the efficiency of the work carried out. To this effect, it is recommended that management need to assess and see how best they can channel resources into this course. Find out the best way to upgrade the various laboratories into a standard that help in the progress of the division and organization in terms of the quality of the workout.

6.6 Equipments and machineries for calibration

Instruments or equipments are essential to the success of any given calibration. Without them it is impossible for any measure to be made in the various laboratories. According to the results received from the study, a vast majority of the respondents believe that the division needs to acquire modern and a more effective equipments and machineries in order to improve the efficiency of the work output. It is therefore recommended that management should try and find out what are the latest measuring device and their accuracy and see if they correspond to the requirement of the job and try to acquire them. This would help employees to improve upon their work and makes it easy to complete their task fast and more accurate.

Furthermore, it is recommended that management should not just only reply of equipments but also assess the need to match the number of employees to the jobs available. According to the results from the study, respondents believe there is a need to hire more workforces in the division to help meet the work load in the various laboratories. Management should try and gather intelligence on this issue and come out with a conclusion if there is a need to hire more workforces and if so should do that.

7 CONCLUSION

This study was based on the fundamental principle of quality and continuous improvement. Considering the importance and contribution of quality management to any given organization and the competitive edge it could add up towards achievement of an organizational objectives, many organizations around the world are deploying the use certain quality tools to assess and find areas to improve for the betterment of their respective firms.

This study focused mainly on the use of Six Sigma to assess certain key areas within the metrology division of Ghana Standards Authority that needs to be carefully looked into in order to help improve the efficiency of the calibration carried out in the various departments of the division. When this is done it would help in the overall progress of the organization towards achieving it future vision of becoming the model of excellence standardization in Africa.

The Six Sigma is a simple technique that helps to eliminate defects in any given process. However due to its effectiveness in its implementations, various organizations including the medical fields have used it to assess and find various ways to improve their service. It is basically a data driven approach, where analysis are made based on gathered data in order to help come up with reasonable and valid conclusions..

Analysis from the data gathered through the questionnaires that were submitted to the employees gave a holistic view of certain possible and key areas that management needs to address in order to help improve performance and aid in the progress of the organization towards achieving it future objective.

The results from the study gave a general idea of which areas or variables management needs to be carefully analyzed and see how best they can improve and effect changes to enhance the efficiency of the work carried out in the various departments.

Edward W. Deming known for his massive contributions in the field of quality management said “*What should be the aim of management? What is their job? Quality is the responsibility of the top people. Its origin is in the boardroom. They are the ones who decide*”. Management must therefore get more involved and try to assess the situations on ground and find solutions on how they can implement changes for the progress of the organization.

7.1 Future research possibilities

Certain limitations were identified during the course of the study among which was that the study was conducted in one division and hence difficult to tell if the situation is the same for the remaining divisions. It is therefore recommended that a similar study should be conducted in the remaining divisions. This would help management get a bigger picture of which areas needs to be improved in the remaining department for the progress of the organization.

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APPENDICES

Appendix 1: Questionnaire



Faculty of Technology

Industrial Management Department

I am Issah Musah, offering Masters of Science (MSc) in Industrial management at the University of Vaasa. I am currently working on my final thesis on the topic **“implementing the use of six sigma for quality and continuous improvement”**. The aim of the study is to find out which areas within operation need to be addressed in order to improve upon the performance of the division.

The Six Sigma has five steps; Define, Measure, Analyze, Improve and Control. By answering the questions below, it would help measure and analyze the areas which need to be improved in order to upgrade the quality of service provided to the customer. Please answer the following question by selecting either 1,2,3,4 or 5.

1: Strongly agree

2: Agree

3: Strongly disagree

4: Disagree

5: Neither agree nor disagree

1) Which of the following areas need to be addressed in order to bring out the best out of the employees?

- Employees need further training to enhance their skills.

1 2 3 4 5

- Employees need to follow standard working procedures to enhance good results.

1 2 3 4 5

- The division needs more manpower

1 2 3 4 5

2) Which of the following areas need to be addressed in order to improve upon the working process?

- Working procedures must be documented and made accessible to all employees who need them.

1 2 3 4 5

- Employees do not follow the right working process or guideline

1 2 3 4 5

- Documentation of calibration carried out needs to be properly done

1 2 3 4 5

3) Which of the following needs to be addressed regarding the type of equipment or machinery used for calibration?

- The need to acquire modern calibration equipments to improve the efficiency of the work output.

1 2 3 4 5

- The division needs more workforce to be able to meet the volume of work it receives

1 2 3 4 5

4) Which of the following needs to be addressed regarding the working environment?

- The ambient condition for measurement in the various laboratories needs to be properly checked during measurement.

1 2 3 4 5

- There are no instruments to check for the ambient temperature and humidity in the various laboratories.

1 2 3 4 5

- There are limited spaces in the various laboratories, which makes working a bit difficult.

1 2 3 4 5

- The laboratories must be upgraded in terms of facilities and training to enhance the efficiency and accuracy of calibration results.

1 2 3 4 5

5) Which of the following needs to be addressed regarding management involvement to the quality of work output?

- Management need to get more involved in quality issues regarding the nature and output of the work.
1 2 3 4 5
- Management need to quickly address problems presented to them by the employees.
1 2 3 4 5

6) Which of the barriers below in your opinion hinders the implementation of the division's strategies?

- The vision barrier (very few of the workforce understands the organization's visions and strategies)
1 2 3 4 5
- The management barrier (executive teams or management spend less than one hour per month discussing about the division's strategies)
1 2 3 4 5
- The resource barrier (resources are not linked to achieving strategic objectives)
1 2 3 4 5
- The people barrier (management do not link incentives that encourage workers in attaining strategic objectives)
1 2 3 4 5

